Gude Landfill
Nature and Extent Study Report
Amendment No. 1
Montgomery County, Maryland

Prepared by:

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LIST OF ACRONYMS AND ABBREVIATIONS

ATC	Anticipated Typical Concentration
bgs	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
COC	Contaminant of Concern
COD	Chemical Oxygen Demand
CSM	Conceptual Site Model
DCE	Dichloroethene
DEP	Department of Environmental Protection
DPS	Department of Permitting Services
EA	EA Engineering, Science, and Technology, Inc.
EPA	U.S. Environmental Protection Agency
ft	Foot or Feet
GLCC	Gude Landfill Concerned Citizens
MCL	Maximum Contaminant Level
MDE	Maryland Department of the Environment
mg/kg	Milligram(s) Per Kilogram
mg/L	Milligram(s) Per Liter (equivalent to parts per million, ppm)
M-NCPPC	Maryland-National Capital Park and Planning Commission
MS4	Municipal Separate Storm Sewer System
MW	Monitoring Well
NES	Nature and Extent Study
NMOC	Non-Methane Organic Compound
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Unit
OB	Observation
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
ppb	Parts Per Billion
RCRA	Resource Conservation and Recovery Act

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

SCFM	Standard Cubic Feet Per Minute
SG	Stream Gauge
SVOC	Semivolatile Organic Compound
TCE	Trichloroethene
TDS	Total Dissolved Solids
TGW	Temporary Groundwater Well
VC	Vinyl Chloride
VOC	Volatile Organic Compound
WSSC	Washington Suburban Sanitary Commission
µg/L	Microgram(s) Per Liter (equivalent to parts per billion, ppb)
$\mu g/m^3$	Microgram(s) Per Cubic Meter

EXECUTIVE SUMMARY

The Montgomery County (the County) Department of Environmental Protection (DEP) was directed by the Maryland Department of the Environment (MDE) to conduct a Nature and Extent Study (NES) of environmental impacts in the vicinity of, and potentially resulting from, the Gude Landfill (the Landfill). The purpose of the study was to characterize the nature and extent of potential Landfill impacts on groundwater, surface water, and surface and subsurface soils, and to conduct hydrogeologic and fate and transport assessments of potential Landfill impacts. The NES was completed in 2010, and the NES Report was submitted to MDE in November 2010. MDE provided comments to DEP, which were discussed in a meeting in February 2011. In order to fully address the issues in MDE's comments, DEP completed additional field investigations and prepared this NES Report Amendment No. 1.

The following investigative field work was performed to further define the nature and extent of potential impacts to groundwater at along the property boundary of the Landfill, and to further understand the relationship between groundwater and surface water elevations:

- Sampling of all existing groundwater monitoring wells (MW) and observation wells (OB)
- Field filtering of groundwater samples collected for metals analysis
- Installation and sampling of three (3) permanent groundwater monitoring wells, MW-14A, MW-14B and MW-15
- Installation and sampling of ten (10) temporary groundwater monitoring well (TGW) locations, TGW-1 through TGW-10
- Elevation survey at fifteen (15) stream gauge (SG) locations, SG-1 through SG-15

Potential impacts to groundwater from the Landfill were identified in the NES Report and consisted of seven (7) contaminants of concern (COCs). Based on historical and NES sampling event (July/August 2010) data, reported concentrations of COCs have consistently exceeded U.S. Environmental Protection Agency (EPA) maximum contaminant levels (MCLs) for drinking water, in one (1) or more groundwater monitoring wells. Based on comments received by MDE, NES Amendment No. 1 defines potential impacts to groundwater from the Landfill as all current MCL exceedances. NES Amendment No. 1 included the evaluation of two (2) additional groundwater sampling events: the County semi-annual sampling event (April 2011) performed by County DEP and the NES Amendment No. 1 sampling event (September 2011) performed by EA Engineering, Science, and Technology, Inc. (EA). During the two (2) additional groundwater sampling events, the following eleven (11) constituents exceeded MCLs (metals – 1, VOCs – 9 and leachate indicator parameters – 1):

- Cadmium, dissolved – 1 location
- 1,1-Dichloroethene (DCE) – 1 location
- 1,2-Dibromoethane – 1 location
- 1,2-Dichloropropane – 2 locations
- Benzene – 1 location
- cis-1,2-DCE – 2 locations
- Methylene Chloride – 4 locations
- Tetrachloroethene (PCE) – 5 locations
- Trichloroethene (TCE) – 9 locations
- Vinyl Chloride (VC) – 6 locations
- Nitrate – 2 locations

The NES Report Amendment No. 1 includes the following information and findings which support the conclusions of the NES Report:

- ***Nature and Extent of Potential Impacts to Groundwater*** − In the NES Report, consistent with historical reports, the highest volatile organic compound (VOC) concentrations in groundwater, including multiple MCL exceedances, were reported for samples collected along the north-northwestern and south-central boundaries of the Landfill. In the NES Amendment No. 1, evaluation of additional data (County semi-annual sampling event [April 2011] and NES Amendment No. 1 sampling event [September 2011]) from existing groundwater monitoring wells, new groundwater monitoring wells (MW-14A, MW-14B and MW-15) located in Derwood Station residential development and temporary groundwater monitoring wells (TGW-1 through TGW-10) for the potential impacts to groundwater indicated consistency with historical data with respect to MCL exceedances on, and in the vicinity of, the Landfill:
    - Reported concentrations for field-filtered groundwater samples indicated that metals exceedances noted during the NES sampling event (July/August 2010), NES Amendment No. 1 sampling event (September 2011) and County semi-annual sampling event (April 2011) for total metals were due to high turbidity (i.e., sediment suspended in groundwater). The lower concentrations of dissolved metals in field-filtered samples are more representative of conditions of the chemical characteristics of groundwater as it migrates through the subsurface.
    - No MCL exceedances were reported in groundwater samples collected from the new groundwater monitoring wells in the Derwood Station residential development (MW-14A, MW-14B and MW-15) during the NES Amendment No. 1 sampling event (September 2011).
    - MCL exceedances were reported in groundwater samples collected from permanent groundwater monitoring wells MW-4, MW-7, MW-8, MW-13A, OB03, OB04A, OB11, OB11A and OB12 during the County semi-annual

sampling event (April 2011). The horizontal extent of the MCL exceedances was along the northwestern, northern, south-central and southeastern Landfill property boundary. Two (2) MCL exceedances were reported in permanent groundwater monitoring wells beyond the Landfill property boundary in OB04A (to the north) and OB12 (to the southwest). These concentrations are consistent with shallow and deep groundwater concentrations that were noted in previous NES and County sampling events, with the exception of two (2) first time MCL exceedances: 1,2-dibromoethane in OB11A and 1,1-dichloroethene in OB11. The results therefore support the findings of the NES Report.

- MCL exceedances were reported in groundwater samples collected during the NES Amendment No. 1 sampling event (September 2011) from TGWs in the north by northwest (TGW-6) and south by southwest (TGW-5) areas adjacent to and beyond the Landfill property boundary. These concentrations are consistent with shallow and deep groundwater concentrations that were noted in previous NES and County sampling events and therefore support the findings of the NES Report.
- Similar to the findings of the NES Report, groundwater elevation data collected from the groundwater monitoring wells and stream gauge locations indicated an easterly flow direction across the Landfill, with minor north, northeasterly and southeasterly components. Stream gauge elevations were in agreement with groundwater table elevations from adjacent groundwater monitoring wells, indicating hydraulic connection between groundwater and surface water.
- The additional groundwater sampling data indicated that in most areas adjacent to and beyond the Landfill property boundary, potential impacts to groundwater that were reported in previous NES and County sampling events in shallow groundwater were not detected in shallow groundwater samples located beyond the adjacent surface water bodies; thus, the Crabbs Branch and Southlawn Branch streams act as hydraulic barriers to contaminant migration.
- Based on the NES sampling event (July/August 2010), the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), MCL exceedances were observed at the greatest frequency in OB11, OB11A, OB03 and MW-13A. However, the vertical extent of MCL exceedances were observed in various groundwater monitoring wells ranging in screen depths from two (2) to one hundred fifty-four (154) feet (ft) below ground surface (bgs), mostly screened within bedrock.
- Seasonal trends indicate that MCL exceedances are likely to continue fluctuating in groundwater monitoring wells within the Landfill monitoring network. Not

enough data was available to evaluate trends for dissolved cadmium or nitrate. MCL exceedances for 1,1-DCE and 1,2-dibromoethane are not consistent with historical results and therefore, no trends were identified. In addition to seasonal trends, there were several groundwater monitoring wells with increasing trends for cis-1,2-DCE and methylene chloride. No other increasing or decreasing trends were determined.

  - Potential sources of impacts to groundwater were evaluated and included on-site and off-site sources. On-site sources of potential impacts to groundwater were identified as waste, leachate and landfill gas. Potential off-site sources of groundwater impacts were also evaluated and include heavy industry and urban environments such as urban roadways, urban residential developments and recreational land use.

- ***Landfill Surface Hydrology –*** A review of the site topography, stormwater infrastructure, and improvements to the Landfill's cover system and drainage network was performed. The review supports that the Landfill's topography and existing stormwater drainage structures minimize standing water (e.g., ponding) and infiltration into the waste mass.
- ***Landfill Gas Management and Groundwater Quality*** − An evaluation of constituents found in landfill gas and groundwater (through analytical testing) identified a correlation of fifteen (15) constituents in both media. Based on the County DEP's active landfill gas management and collection system at the Landfill it can be inferred that landfill gas management at the site has been providing benefits to groundwater quality by removing the potential for VOC constituents (at the relative concentrations) to condense and enter into the groundwater at and in the vicinity of the Landfill.
- ***Human Health and Ecological Risk Evaluations*** − Groundwater analytical results from the groundwater monitoring wells within the Landfill monitoring network identified risk-based COCs with concentrations that are consistent with historical analytical results, including the NES sampling event (July/August 2010). As noted in the NES Report, vapor intrusion of VOCs into indoor air is the only complete exposure pathway for residents in Derwood Station residential development. The County semi-annual sampling event (April 2011) and NES Amendment No. 1 sampling event (September 2011) indicated no VOCs as risk-based COCs because the concentrations are below a level of concern for human health within the Derwood Station residential development. Therefore, there are no human health concerns for residents' exposure to VOCs in groundwater within Derwood Station residential development.
- ***Potential Impacts to Surface Water*** − Based on the findings provided in the NES Report, the Landfill is not adversely impacting adjacent surface water bodies and no further

assessments on potential surface water impacts from or in the vicinity of the Landfill are required at this time. However, potential offsite sources of impacts to surface water may include: urban roadways, urban residential development, recreational and heavy industry.

In general, the results of the NES Amendment No. 1 support the findings of the NES Report. The primary findings of the NES Study include the following:

- Groundwater flow around the Landfill is to the east and south, with minor flow components to the north and northeast in the northern portions of the site.
- Consistent with historical reports, the highest VOC concentrations in groundwater, including multiple MCL exceedances, were reported for samples collected along the north-northwestern and south-central boundaries of the Landfill.
- One (1) exceedance of MDE Cleanup Standards for Groundwater was reported in surface water, for cobalt, in a small drainage area northeast of the Landfill. This single isolated exceedance is consistent with the occasional, isolated exceedances reported during historical surface water sampling events.
- The reported concentrations of arsenic, chromium, cobalt and vanadium exceeded MDE Residential Cleanup Standards for Soil, but are consistent with typical background concentrations published by MDE. Two (2) polychlorinated biphenyl (PCB) exceedances were also reported, one (1) each in the surface and subsurface soils.
- The only potential human health concern identified related to groundwater would arise if the aquifer were used as a potable water supply; however, this is currently an incomplete exposure pathway due to the availability of a public water supply from Washington Suburban Sanitary Commission (WSSC) in nearby communities.
- The isolated detections of PCBs in surface and subsurface soils indicate that there is not a site-wide PCB concern and that PCBs in soil are not likely to result in human health concerns at the Landfill site.
- For surface and subsurface soils, reported metals and high molecular weight polycyclic aromatic hydrocarbon (PAH) concentrations are consistent with reference concentrations or MDE-published background levels, and do not present ecological or human health concerns.

The NES Amendment No. 1 further defines the nature and extent of potential impacts to groundwater from the Landfill, provides clarification on metals exceedances and addresses MDE comments on landfill surface hydrology, landfill gas management, human health and ecological risk evaluations and potential impacts to surface water.

1. INTRODUCTION

The Montgomery County (County) Department of Environmental Protection (DEP) submitted a Nature and Extent Study (NES) Report for the Gude Landfill (Landfill) to the Maryland Department of the Environment (MDE) on November 19, 2010. The NES Report was prepared by EA Engineering, Science, and Technology, Inc. (EA) with input from the County DEP.

On February 23, 2011, representatives of DEP, EA and MDE met to discuss MDE's comments and questions on the NES Report. Based on this meeting, DEP prepared Meeting Minutes and an MDE Comment/County Response Document to summarize specific guidance from MDE to DEP on the necessary steps to finalize the NES Report for the Landfill. DEP submitted the Comment/Response Document to MDE via email on March 30, 2011. MDE formally accepted the Comment/Response Document via letter on May 11, 2011. The Meeting Minutes and the Comment/Response Document are included in **Appendix A**.

The results of the additional investigations, analyses and field work required under the MDE Comment/County Response Document are provided herein as Amendment No. 1 to the NES Report. Wherever feasible and necessary, pertinent information from the NES Report (as submitted on November 19, 2010) has been excerpted into Amendment No. 1 to fully address MDE's comments in a comprehensive format and to minimize cross references.

Based on MDE's comments, Amendment No. 1 was prepared to supplement the NES Report with the following direction:

- Further characterize the nature of potential impacts to groundwater resulting from the Landfill and identify any contributing factors to such impacts (NES Amendment No. 1 Section 3).
- Further evaluate and characterize the extent of maximum contaminant level (MCL) exceedances through additional groundwater sampling and analyses in the following areas of the Landfill site: northwest, northeast, southwest and southeast (NES Amendment No. 1 Sections 2, 3 and 4).
- Address the source of metals exceedances, particularly chromium in the groundwater sampling data. Determine the effect of turbidity on total metal exceedances (NES Amendment No. 1 Section 3).
- Analyze groundwater samples for the following leachate indicator constituents: pH, alkalinity, hardness, chloride, specific conductance, nitrate, chemical oxygen demand

(COD), turbidity, ammonia, sulfate and total dissolved solids (NES Amendment No. 1 Section 3).

- Evaluate seasonal variation trends in groundwater sampling data (NES Amendment No. 1 Section 3).
- Address the potential impacts of industrial operations along Southlawn Lane on groundwater and surface water quality in the vicinity of the Landfill (NES Amendment No. 1 Section 3 and 8).
- Discuss the nature and extent and provide graphical depictions of other constituents including metals that exceed individual groundwater protection standards. Impacts should be presented at the single constituent (i.e., parameter) level where groundwater protection standards are exceeded (NES Amendment No. 1 Section 3 and 4).
- Further characterize the extent of potential impacts to groundwater resulting from the Landfill and identify contributing factors to such impacts. The extent of potential impacts should be bounded (NES Amendment No. 1 Section 4).
- Include surface water elevations from bordering streams and include the data in the groundwater contour details. The groundwater contour map should be presented on a topographic map. Report text should more closely reflect aspects of the Landfill's topography and the apparent flow direction of surface water bodies along the perimeter Landfill property boundary. More localized (e.g., radial) groundwater flow components of the Landfill site should be provided in an attempt to close the groundwater contours (NES Amendment No. 1 Section 2 and Section 4).
- Address landfill surface hydrology. Specifically the way in which the Landfill's topography and existing stormwater drainage structures minimize standing water (e.g., ponding) and infiltration into the waste mass (NES Amendment No. 1 Section 5).
- Compare landfill gas composition data with groundwater monitoring data to evaluate the potential positive effects of enhanced landfill gas collection on groundwater quality (NES Amendment No. 1 Section 6).

2. ADDITIONAL INVESTIGATIONS AND ANALYSES

In accordance with the MDE Comment/County Response Document (Appendix A), County DEP in conjunction with EA completed a series of additional investigations (e.g., field work) and analyses to obtain supplemental information to the NES Report. The additional investigations and analyses associated with Amendment No. 1 of the NES Report at, and in the vicinity of, the Landfill are summarized below.

2.1 INVESTIGATIVE FIELD WORK

In order to address MDE's comments, additional investigative field work was conducted to further define the nature and extent of potential groundwater impacts from the Landfill. Potential impacts to groundwater from seven (7) contaminants of concern (COCs) were identified in the NES Report. Based on historical and NES sampling event (July/August 2010) data, reported concentrations of COCs have consistently exceeded U.S. Environmental Protection Agency (EPA) MCLs for drinking water, in one (1) or more groundwater monitoring wells. Based on comments received by MDE, NES Amendment No. 1 addresses all current MCL exceedances as potential impacts to groundwater from the Landfill.

The following investigative field work was performed to further define the nature and extent of potential impacts to groundwater along the property boundary of the Landfill, and to further understand the relationship between groundwater and surface water elevations:

- Sampling of all existing groundwater monitoring wells (MW) and observation wells (OB)
- Installation and sampling of three (3) permanent groundwater monitoring wells, MW-14A, MW-14B and MW-15
- Installation and sampling of ten (10) temporary groundwater monitoring well (TGW) locations, TGW-1 through TGW-10
- Elevation survey at fifteen (15) stream gauge (SG) locations, SG-1 through SG-15

The locations of MWs, TGWs and SGs are presented on **Figure 2-1** – Additional Groundwater Monitoring Well and Stream Gauge Survey Locations. Field filtering of metals was performed for each sampling location to determine the fraction of metals associated with suspended sediment versus the fraction dissolved in groundwater. Permanent MWs were installed to confirm the nature and extent of potential groundwater impacts in the Derwood Station residential community, to the northwest of the Landfill; temporary groundwater monitoring wells were installed to verify the nature and extent of potential groundwater impacts and evaluate whether adjacent streams are hydraulic barriers that restrict contaminant migration; and stream gauge elevations were surveyed to illustrate the relationship between surface water elevations in adjacent streams and groundwater table elevations. Groundwater monitoring well construction data is summarized in **Table 2-1**.

2.2 PROPERTY ACCESS APPROVAL AND ACCESS PERMITS

Prior to installing the MWs and TGWs and surveying the SGs, County DEP and EA obtained property access approvals and access permits, which are identified below:

- Maryland-National Capital Park and Planning Commission (M-NCPPC)
  - Permit for Construction on Park Property was obtained on July 13, 2011
    - Installation of TGW-6, 7, 8, 9, 10
    - Elevation survey of SG-2, 9, 11, 12, 13, 14, 15
- Washington Suburban Sanitary Commission (WSSC)
  - Right-of-Entry Agreement was obtained on August 19, 2011
    - Installation of TGW-2, 3, 4, 5
    - Elevation survey of SG-4, 5, 7, 8
- Transcontinental/Williams Gas Right-of-Way
  - Access was not required, as heavy equipment was not used to install the TGWs
  - Coordination and site review was performed with Field Manager on July 8, 2011
- Columbia Gas Right-of-Way
  - Access was not required, as heavy equipment was not used to install the TGWs
  - Coordination and site review was performed with Field Manager on July 8, 2011
- County DEP Landfill Property
  - Access approvals and permits were not required – land is owned by County DEP
  - Installation of TGW-1 and elevation survey of SG-1, 3, 6, 10
- County Right-of-Way Property along Indianola Drive and Bettendorf Court in the Derwood Station Residential Development
  - Access approval for County Right-of-Way accompanies the groundwater monitoring well installation permits by the County Department of Permitting Services (DPS) and the State of Maryland
    - Installation of MW-14A, MW-14B, MW-15

The above referenced property designations for the MWs, TGWs and SGs represent installed and surveyed conditions.

2.3 GROUNDWATER MONITORING WELL INSTALLATION PERMITS

Prior to installing the MWs, EA obtained the necessary groundwater monitoring well installation permits, which are identified below:

- State of Maryland Application for Permit to Drill Well; approval by State of Maryland Health Department dated July 14, 2011
- State of Maryland Well Completion Report; submitted by driller to the State of Maryland on October 5, 2011
- County DPS Well Location Permit; issued to Gude Landfill on July 15, 2011

In accordance with guidance from County DPS, permits were not required for the TGWs, if the TGWs were abandoned within thirty (30) days of installation or via an approved time extension. State of Maryland Well Completion Reports for permanent MWs are included in **Appendix B**, along with boring logs, development records and construction diagrams. Construction diagrams for temporary groundwater monitoring wells are provided in **Appendix C**.

2.4 SCHEDULE OF INVESTIGATIVE FIELD ACTIVITIES

Groundwater sampling of all existing monitoring and observation (OB) wells occurred as part of the MDE approved sampling program April 18 through April 26, 2011. After obtaining access approvals and installation permits, EA performed the following groundwater sampling and stream gauge surveying activities:

- Installation and development of the MWs occurred August 1 through August 3, 2011.
- Installation and development of the TGWs occurred August 5 through August 23, 2011.
- Groundwater gauging (i.e., elevation measurements) of all thirty-six (36) existing groundwater MWs, OB wells, the three (3) new MWs and the ten (10) TGWs occurred on August 30, 2011.
- Elevation survey of SGs occurred on August 30, 2011.
- Groundwater purging and sampling of the MWs occurred on September 2, 2011.
- Groundwater purging and sampling of the TGWs occurred on September 1 through 13, 2011.

- Disposal of purged groundwater to the Oaks Landfill Leachate Pretreatment Facility occurred on October 13, 2011.
- Decommissioning of the TGWs occurred on October 13, 2011.

2.5 GROUNDWATER ANALYSES

Groundwater samples collected from the new MWs and TGWs were analyzed for the following constituents, consistent with those included in the NES Report:

- Volatile organic compounds (VOCs) by U.S. EPA Method 8260;
- Semivolatile organic compounds (SVOCs) by EPA Method 8270;
- Metals by EPA Method 6020;
- Herbicides by EPA Method 8151;
- Chlorinated pesticides by EPA Method 8081;
- Organophosphate pesticides by EPA Method 8141;
- Polychlorinated biphenyls (PCBs) by EPA Method 8082;
- Cyanide by EPA Method 9010;
- Sulfide by EPA Method 9030; and
- Leachate indicator parameters: pH, alkalinity, hardness, chloride, specific conductance, nitrate, COD, turbidity, ammonia, sulfate and total dissolved solids (TDS).

Due to the nature of the construction of the TGWs and the depth of the wells in the subsurface, slow groundwater recharge into the well resulted in insufficient sample volumes to perform all planned analyses. Initial sampling of the TGWs occurred on September 1 and 2, 2011, with additional sampling performed on September 13, 2011 for those TGWs with insufficient sample volumes. Although sufficient volume was collected to analyze VOCs, total metals, dissolved metals and SVOCs for all TGWs, certain constituents and or groups of constituents were not analyzed due to insufficient volume and are summarized in **Table 2-2**. Groundwater monitoring well and TGW purging and sampling records for the NES Amendment No. 1 sampling event (September 2011) performed by EA are provided in **Appendix D**. Laboratory analytical reports for the NES Amendment No. 1 sampling event (September 2011) performed by EA are provided in **Appendix E**. The analytical results from the NES Amendment No. 1 sampling event (September 2011) performed by EA are discussed further in Sections 3 and 4 in conjunction with the results of the County semi-annual sampling event (April 2011) performed by County DEP to further define the nature and extent of potential impacts to groundwater at the Landfill.

3. NATURE OF POTENTIAL IMPACTS TO GROUNDWATER

As discussed in the NES Report, VOCs and metals have historically exceeded MCLs for samples collected and analyzed from several groundwater monitoring wells at the Landfill. In accordance with the MDE Comment/County Response Document, Section 3 of this report provides the following:

- Further evaluation and characterization of the extent of impacts to groundwater through additional groundwater sampling and analyses in the following areas of the Landfill site: northwest, northeast, southwest and southeast.
- Further characterization of the nature of potential impacts to groundwater resulting from the Landfill and identification any contributing factors to such impacts.
- An evaluation on the source of metals exceedances and the effect of turbidity on total metal exceedances.
- An evaluation of leachate indicator parameters analytical results.
- An evaluation of seasonal variation trends in groundwater sampling data.
- A discussion regarding the potential impacts of industrial operations along Southlawn Lane on groundwater and surface water quality in the vicinity of the Landfill.
- Graphical depictions of constituents, including metals, that exceed individual groundwater protection standards. Impacts are presented at the single constituent (i.e., parameter) level where groundwater protection standards are exceeded.

3.1 GROUNDWATER MONITORING DATA REVIEW

MCL exceedances were evaluated as potential impacts to groundwater from the Landfill . The NES identified ten (10) constituents with concentrations greater than MCLs during the NES sampling event (July/August 2010) and fourteen (14) constituents with concentrations greater than MCLs during the Fall County semi-annual sampling event (September 2010). Of the MCL exceedances reported, there were several MCL exceedances for metals that were noted. Typical leachate indicator parameters were not analyzed as part of the NES sampling event (July/August 2010).

Groundwater monitoring data evaluated as part of the NES Amendment No. 1 consists of two (2) additional groundwater sampling events: the County semi-annual sampling event (April 2011) performed by County DEP and the NES Amendment No. 1 sampling event (September 2011) performed by EA. Analyses for typical leachate indicator parameters were completed during the

County semi-annual event (April 2011), as well as for monitoring locations installed and sampled by EA as part of additional NES Amendment No. 1 investigations (September 2011). Additionally, metals exceedances were further evaluated (using field filtration of samples) to discern the presence of metals dissolved in groundwater versus the fraction present within sediment suspended in groundwater during the sampling process. During the two (2) additional groundwater sampling events, the following eleven (11) constituents exceeded MCLs (metals – 1, VOCs – 9 and leachate indicator parameters – 1):

- Cadmium, dissolved – 1 location
- 1,1-Dichloroethene (DCE) – 1 location
- 1,2-Dibromoethane – 1 location
- 1,2-Dichloropropane – 2 locations
- Benzene – 1 location
- cis-1,2-DCE – 2 locations
- Methylene Chloride – 4 locations
- Tetrachloroethene (PCE) – 5 locations
- Trichloroethene (TCE) – 9 locations
- Vinyl Chloride (VC) – 6 locations
- Nitrate – 2 locations

Analytical results for the sampling events are provided in tabular format in **Appendix F,** and historical analytical data tables are presented in **Appendix G**.

3.1.1 Metals

Total metals have historically been a source of sporadic MCL exceedances within the Landfill groundwater monitoring well network. As a result, it was hypothesized that these exceedances were likely a result of suspended sediment in groundwater resulting from the sampling of the groundwater monitoring well and not metals dissolved in groundwater. This is typically evident by the measurement of high turbidity when sampling groundwater monitoring wells. Since this data had not been consistently measured, no clear connection could be made from historical data. Therefore, in order to evaluate the nature of metals exceedances within the Landfill groundwater monitoring well network, turbidity was measured and both total and dissolved metals fractions were analyzed for the 2011 semi-annual County monitoring (April 2011) and NES Amendment No. 1 (September 2011) sampling events. Comparisons of total and dissolved metals MCL exceedances are summarized in **Table 3-1**.

Based on the reported concentrations of dissolved metals, it was concluded that the presence of suspended sediment in unfiltered groundwater samples caused reported total metals concentrations that were not representative of groundwater conditions. Therefore, total metals concentrations are omitted from **Table 3-2,** which summarizes MCL exceedances by location and **Table 3-3,** which summarizes MCL exceedances by constituent. A comparison of MCL exceedances for the NES sampling event (July/August 2010) and the County semi-annual sampling event (April 2011) are presented in **Table 3-4**. In general, concentrations for the County semi-annual sampling event (April 2011) were less than the NES sampling event (July/August 2010).

Permanent Groundwater Monitoring Wells

During the NES sampling event (July/August 2010) and the Fall County semi-annual sampling event (September 2010) evaluated as part of the NES, total chromium concentrations exceeded MCLs for the first time in groundwater monitoring wells MW-9, MW-10, MW-11A (located in the Derwood Station residential development) and off-site groundwater monitoring well OB06 (located northeast of the Landfill on MNCPPC property). Since 2001, chromium has sporadically been detected in various groundwater monitoring wells within the groundwater monitoring well network (on- and off-site). Of those detections prior to 2010, there were only five (5) MCL exceedances of chromium, in groundwater monitoring wells OB105 (September 2002, 2004 and 2006), OB025 (September 2009) and OB102 (October 2007).

During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), there were no exceedances of chromium reported in the permanent groundwater monitoring wells. Based on the nature of the exceedances, chromium in groundwater is likely a result of suspended sediment and is not indicative of contamination from the Landfill. During the installation of groundwater monitoring wells MW-9, MW-10 and MW-11A installed as part of the NES in 2010, subsurface soil samples were collected and analyzed for total metals. The reported concentrations of chromium at all boring locations exceeded the cleanup standard; however, the concentrations of chromium were generally similar to the anticipated typical concentrations (ATCs) in Maryland (MDE 2008), and therefore were determined to likely represent soil background levels.

For the permanent groundwater monitoring wells during the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), turbidity was measured during the 3-volume well purge process and was recorded by the EA technician in field notes. Elevated turbidity measurements (greater than 750 nephelometric turbidity units

[NTUs]) were observed and sustained in several of the groundwater monitoring wells during the purging process. The groundwater monitoring wells with elevated turbidity were allowed up to twenty-four (24) hours for recharge prior to sampling. The following groundwater monitoring wells experienced elevated turbidity levels following purging: OB06, OB025, OB105, MW-3B, MW-6, MW-10 and MW-11A.

In the permanent groundwater monitoring wells, the reported concentrations of four (4) total metals exceeded MCLs at five (5) locations:

- Total lead exceeded the MCL action level (0.015 milligrams per liter [mg/L]) in OB06, OB11A, MW-11A and MW-3B;
- Total mercury exceeded the MCL (0.002 mg/L) in OB06; total beryllium exceeded the MCL (0.004 mg/L) in OB11A; and
- Total cadmium exceeded the MCL (0.005 mg/L) in OB11 and OB11A.

Of the total metals MCL exceedances, only cadmium in groundwater monitoring well OB11 exceeded the MCL for the field filtered sample (dissolved fraction), indicating that cadmium was dissolved in groundwater. The dissolved fraction concentration of 0.0106 mg/L is higher than the total fraction result of 0.0100 mg/L. Total cadmium concentration slightly exceeded MCLs historically in this location and the adjacent groundwater monitoring well OB11A. Historical Landfill site data indicate that the presence of elevated cadmium is localized in this area. During the installation of groundwater monitoring wells installed as part of the NES in 2010, subsurface soil samples were collected and analyzed for total metals; however, no subsurface soil samples were collected in the vicinity of OB11A. For the subsurface soil samples collected, cadmium was not detected. ATCs in Maryland (MDE 2008) for cadmium are 11 milligrams per kilogram (mg/kg) in soil. Cadmium is a naturally occurring metal with a high affinity for binding with sediment and organic matter, limiting its transport in groundwater. Its source can also be associated with industrial processes, such as plating and it is also a component of batteries[1]. Based on limited operational data for the Landfill, it is not clear if the dissolved cadmium is naturally occurring or a result of waste placed in the Landfill.

[1] Agency For Toxic Substances & Disease Registry.
http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=15 . Accessed October 2011.

Temporary Groundwater Monitoring Wells

In temporary groundwater wells TGW-1, TGW-3, TGW-6, TGW-7 and TGW-8, the reported concentrations of total arsenic, beryllium, cadmium and chromium exceeded MCLs. For the field-filtered sample fractions (dissolved fraction), most of the reported results were less than the detection limits. The dissolved fraction results indicate that total metal exceedances are a result of suspended sediment and are not representative of groundwater. The only other metal detected was arsenic in TGW-7, for which the reported concentration was less than the MCL of 0.01 mg/L.

Findings

Based on investigations performed as part of the NES Amendment No. 1, there are no metals that are indicative of potential impacts to groundwater from the Landfill. Of the total metals MCL exceedances, only cadmium in groundwater monitoring well OB11 exceeded the MCL for the field filtered sample (dissolved fraction). Cadmium is a naturally occurring metal with a high affinity for binding with sediment and organic matter, limiting its transport in groundwater. During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), there were no exceedances of chromium reported in the permanent groundwater monitoring wells. Based on the nature of the exceedances, chromium in groundwater is likely a result of suspended sediment and is not indicative of contamination from the Landfill. Continued implementation of refined sampling practices (e.g., field filtration of samples) may be required to define and eliminate total metal exceedances that occur as a result of high turbidity within certain groundwater monitoring wells in future groundwater sampling events.

3.1.2 VOCs

Results from the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011) were generally consistent with, or less than, historical results. **Table 3-2** summarizes MCL exceedances by location, and **Table 3-3** summarizes MCL exceedances by constituent.

Permanent Groundwater Monitoring Wells

Twenty-five (25) VOCs were detected in twenty-nine (29) of the permanent groundwater monitoring wells for the County semi-annual sampling event (April 2011) and the NES

Amendment No. 1 sampling event (September 2011). Of the twenty-five (25) VOCs detected, nine (9) VOCs exceeded MCLs: PCE, TCE, cis-1,2- DCE, VC, benzene, methylene chloride, 1,2-dichloropropane, 1,2-dibromoethane and 1,1-dichloroethene. Of the nine (9) VOCs that exceeded MCLs, two (2) were first time MCL exceedances: 1,2-dibromoethane in OB11A and 1,1-dichloroethene in OB11.

The detection of 1,2-dibromoethane in OB11A (1.8 micrograms per liter [µg/L]) is not consistent with historical data for the site. Prior to the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), 1,2-dibromoethane had been detected at the site only once before, at surface water sampling location ST015 at a concentration of 2.56 µg/L, during the Spring 2006 sampling event. ST015 is upgradient of the Landfill. Based on the nature of the two (2) detections and the presence of the contaminant upgradient of the Landfill, it is unlikely that the source of the detections is the Landfill. 1,2-Dibromoethane is a manufactured chemical historically used as a pesticide in soil and currently used for the treatment of logs for termites and beetles, control of moths in beehives and as a preparation for dyes and waxes[2].

1,1-Dichloroethene has historically been detected in groundwater monitoring well OB11 at low to trace concentrations. The detection for the County semi-annual sampling event (April 2011) of 25 µg/L was significantly higher than concentrations reported to date. The second highest reported concentration at the site was 1.71 µg/L in OB11A during the April 2002 sampling event. The results are not consistent with historical data.

Only one (1) VOC was detected in the groundwater monitoring wells MW-14A, MW-14B and MW-15 located within the Derwood Station residential development. Chloroform was detected at trace to low concentrations (0.9 J µg/L to 2 µg/L). Chloroform is a disinfection byproduct and is part of a group of constituents identified as trihalomethanes. There were no detections exceeding the MCL for trihalomethanes (80 µg/L).

Temporary Groundwater Monitoring Wells

Twelve (12) VOCs were detected in five (5) of the TGW locations (TGW-3, TGW-4, TGW-5, TGW-6 and TGW-8) installed as part of the NES Amendment No. 1 investigations: 1,1-DCE, 1,2-dichloroethane, 1,2-dichloropropane, 1,4-dichlorobenzene, benzene, chlorobenzene,

[2] Agency For Toxic Substances & Disease Registry. http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=131 . Accessed October 2011.

dichlorodifluoromethane, PCE, TCE, cis-1,2-DCE, trans-1,2-DCE and VC. Detections of these twelve (12) VOCs were consistent with historical data for the Landfill. Of the twelve (12) VOCs detected, two (2) VOCs exceeded MCLs in temporary groundwater monitoring wells: TCE (MCL equals 5 µg/L) at a concentration of 8 µg/L in TGW-5 and VC (MCL equals 2 µg/L) at a concentration of 3 µg/L and 4 µg/L in TGW-5 and TGW-6, respectively.

In addition to the twelve (12) VOCs detected, acetone was detected in TGW-1, TGW-3, TGW-6, TGW-7, TGW-8 and TGW-9. Prior to 2009, there had only been two (2) detections of acetone at the site. Since then it has been sporadically detected in samples collected throughout the groundwater monitoring network associated with the Landfill. There is no MCL for acetone.

Findings

During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), nine (9) VOCs exceeded MCLs. With the exception of 1,2-dibromoethane in groundwater monitoring well OB11A and 1,1-DCE in groundwater monitoring well OB11, MCL exceedances were generally consistent with historical data.

3.1.3 Leachate Indicator Parameters

As part of the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), additional parameters were analyzed to further define the potential presence of leachate in groundwater from the Landfill. However, in cases of unlined and uncapped landfills (e.g., Gude Landfill), older waste may not produce significant concentrations of typical leachate indicator parameters. Leachate indicator parameters analyzed include pH, alkalinity, hardness, chloride, nitrate, COD, turbidity, ammonia, sulfate and TDS. Of the parameters listed, ammonia, chloride and COD are most likely to indicate the presence of leachate when present in high concentrations.

Nitrate exceeded the MCL (10 mg/L) in groundwater monitoring wells MW-7 (14.9 mg/L) and MW-8 (13.85 mg/L) during the County semi-annual sampling event (April 2011). Nitrate was detected in eighteen (18) permanent groundwater monitoring wells and five (5) temporary groundwater monitoring wells at concentrations less than the MCL. Nitrate was not detected in groundwater monitoring wells OB11 and OB11A where the greatest number of MCL exceedances were reported. Ammonia, which is a typical indicator of leachate, oxidizes to nitrite and then nitrate. Ammonia was detected in thirteen (13) permanent groundwater monitoring wells, including seven (7) of the permanent groundwater monitoring wells where nitrate was reported. Ammonia was also detected in each of the five (5) temporary groundwater monitoring wells where nitrate was reported. Ammonia was detected in groundwater monitoring wells OB03, OB03A and OB11A where the greatest number of MCL exceedances were reported; however, the highest ammonia concentration reported for the County semi-annual sampling event (April 2011) was 25.1 mg/L in OB105. There were no MCL exceedances in OB105 during the County semi-annual sampling event (April 2011).

<u>Findings</u>

Nitrate exceeded the MCL (10 mg/L) in groundwater monitoring wells MW-7 (14.9 mg/L) and MW-8 (13.85 mg/L) during the County semi-annual sampling event (April 2011). Nitrate was not detected in groundwater monitoring wells OB11 and OB11A where the greatest number of MCL exceedances were reported. In general, no strong correlations were observed with regard to leachate indicator parameters and reported VOC detections within the groundwater monitoring network associated with the Landfill. This is likely a result of the waste mass age, potential for groundwater mounding, and the Landfill being unlined and not capped (stormwater management practices at the Landfill reduce overall infiltration). As a result, concentrations of leachate indicator parameters are potentially more diluted, resulting in weak to no correlations within the groundwater monitoring network. Similar results were observed for TGWs, where sufficient volume was present to perform analysis on leachate indicator parameters.

3.2 HISTORICAL TRENDS AND SEASONAL INFLUENCES

Historical trends and seasonal influences for MCL exceedances were evaluated from April 2001 through April 2011. Data from the County semi-annual sampling event (April 2011) was combined with historical data to update MCL exceedance trend plots for individual trends within each groundwater monitoring well from the NES Report, which are included as **Appendix H**.

In addition to the updated MCL exceedance trend plots from the NES Report, trend plots were prepared for each of the eleven (11) constituents which exceeded MCLs during the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), along with a statistical trend analysis to further evaluate historical and seasonal trends. The trend plots show all groundwater monitoring wells on a single graph for each constituent with MCL exceedances during the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011). These trend plots include all groundwater monitoring wells which have had at least one (1) historical detection. Individual constituent trend plots are included as **Exhibits 3-1** through **3-11**.

The trend analysis performed was an autocorrelation, which determines if a relationship exists between the data and various points in time (i.e., temporal dependency). A first-order sample autocorrelation coefficient was computed for data from April 2001 through April 2011 and was evaluated at the 95% significance level in order to identify data series exhibiting temporal dependence. The first-order autocorrelation coefficient r_1 was calculated as the Pearson product-moment correlation coefficient between the first $N-1$ observations, x_t, $t=1,2,...N-1$ and the next $N-1$ observations, x_t, $t=2,3,...N-1$.

$$r_1 = \frac{\sum_{t=1}^{n-1}\left(x_t-\bar{x}_1\right)\left(x_{t+1}-\bar{x}_2\right)}{\left[\sum_{t=1}^{n-1}\left(x_t-\bar{x}_1\right)^2\right]^{1/2}\left[\sum_{t=2}^{n}\left(x_t-\bar{x}_2\right)^2\right]^{1/2}}$$

Where $\bar{x}_1$ is the mean of the first $N-1$ observations and $\bar{x}_2$ is the mean of the last $N-1$ observations.

Data series with first-order autocorrelation exceeding the 95% significance level were identified as exhibiting strong temporal dependence, such as seasonality trend. Trend plots for the eleven (11) MCLs are included as **Exhibits 3-1** through **3-11**. The results of the trend analysis were:

- ***1,1-DCE*** **–** Historically, this constituent has only been detected below the MCL (7 µg/L) in groundwater monitoring wells OB03, OB03A, OB10, OB11 and OB11A at low to trace concentrations. During the County semi-annual sampling event (April 2011) it was only detected in OB01 (1.1 µg/L), which is a first time detection, and OB11 (25 µg/L). As a result, no trends were identified.
- ***1,2-Dibromoethane*** **–** 1,2-Dibromoethane was a first time detection and a first time MCL exceedance for OB11A. There were no other detections. Detection limits for this constituent have historically been greater than the MCL (0.05 µg/L) and have ranged in value from 0.08 µg/L to 2 µg/L. The detection limit for the County semi-annual sampling event (April 2011) was 1 µg/L and the concentration reported for OB11A was 1.8 µg/L. Since this was a first time detection, no trends were identified.
- ***1,2-Dichloropropane*** **–** A seasonal trend was observed with significant autocorrelation in all data sets, except OB01, MW-13A, MW-13B and MW-6. Seasonal trends typically illustrated higher concentrations during Fall groundwater sampling events. For the MW groundwater monitoring wells which were installed during the NES sampling event

(July/August 2010) and the NES Amendment No. 1 sampling event (September 2011), the lack of trend is likely due to the limited data from the groundwater monitoring wells to date. No increasing or decreasing trends were identified.

- ***Benzene –*** A seasonal trend was observed with significant autocorrelation in all data sets, except MW-13A, MW-13B and MW-4 and MW-6. Seasonal trends typically illustrated higher concentrations during Fall groundwater sampling events. For the MW groundwater monitoring wells which were installed during the NES sampling event (July/August 2010) and the NES Amendment No. 1 sampling event (September 2011), the lack of trend is likely due to the limited data from the groundwater monitoring wells to date. No increasing or decreasing trends were identified.
- ***Cadmium, dissolved –*** Data were insufficient to determine if trends exist.
- ***cis-1,2-DCE –*** A seasonal trend was observed with significant autocorrelation in most data sets. Seasonal trends typically illustrated higher concentrations during Fall groundwater sampling events. There is also an apparent increasing trend in data sets OB03A, OB03, OB11A and OB11. These four (4) groundwater monitoring wells appear to have the highest frequency of MCL exceedances. The increase in cis-1,2-DCE may be indicative of the degradation of TCE that is likely occurring in the vicinity of these groundwater monitoring wells.
- ***Methylene Chloride –*** A seasonal trend was observed, with significant autocorrelation in the data set with detected concentrations. Seasonal trends typically illustrated higher concentrations during Fall groundwater sampling events. There is an apparent increasing trend in data sets for OB11 and OB12.
- ***Nitrate –*** Data were insufficient to determine if trends exist.
- ***PCE*** − A seasonal trend was observed, with significant autocorrelation in most data sets. Seasonal trends typically illustrated higher concentrations during Fall groundwater sampling events. No increasing or decreasing trends were identified.
- ***TCE*** − A seasonal trend was observed, with significant autocorrelation in most data sets. Seasonal trends typically illustrated higher concentrations during Fall groundwater sampling events. No increasing or decreasing trends were identified.
- ***VC*** − A seasonal trend was observed, with significant autocorrelation in most data sets. Seasonal trends typically illustrated higher concentrations during Fall groundwater sampling events. No increasing or decreasing trends were identified.

Findings

Seasonal trends indicate that concentrations of parameters with historical MCL exceedances are likely to continue fluctuating in groundwater monitoring wells within the Landfill monitoring network. Not enough data were available to evaluate trends for dissolved cadmium or nitrate. MCL exceedances for 1,1-DCE and 1,2-dibromoethane are not consistent with historical results and therefore, no trends were identified. In addition to seasonal trends, there were several groundwater monitoring wells with increasing trends for cis-1,2-DCE and methylene chloride. No other increasing or decreasing trends were determined.

3.3 POTENTIAL ON-SITE SOURCES OF GROUNDWATER IMPACTS

Landfills by their nature generate concentrated sources of potential impacts (e.g., waste, leachate, landfill gas) to groundwater and surface water. This potential is typically limited for landfills constructed post-Resource Conservation and Recovery Act (RCRA) regulations, when the requirements for the design and construction incorporated the installation of a bottom liner system, leachate collections system and impermeable synthetic cap. The following provides a summary of the nature of contributing sources of contamination from the Landfill.

3.3.1 Waste

Although the Landfill was operated as a municipal solid waste landfill, indicating the majority of waste would be expected to contain residential material such as plastics, glass, metals and food waste, based on the years of operation and the lack of detailed records other materials may have been accepted from industrial sources. As a result, VOCs which originate from industrial sources are likely present and as a result are present in groundwater. For example, PCE and its degradation products (i.e., daughter products) are VOCs which exceed MCLs within the Landfill groundwater monitoring network. PCE and TCE are chlorinated solvents that were heavily used as metal degreasing agents and are a common source of contamination throughout the U.S. It is likely that these chemicals were disposed during a time when their impact on human health and the environment was unknown. Once in the subsurface, these chlorinated solvents are often degraded naturally over long periods of time by microorganisms.

3.3.2 Leachate

Although waste will generate leachate through natural decomposition processes and when exposed to infiltration, the significance of its impact on groundwater is mitigated by engineered systems designed to reduce infiltration and improve stormwater run-off. The generation of leachate is limited today in modern landfills by the presence of an impermeable synthetic capping system (pre-RCRA era landfills may have an engineered soil capping system), which prevents precipitation from percolating through waste and producing leachate. Likewise, a bottom (i.e., base) liner system separates waste from groundwater (by design, landfills today are not placed into groundwater) and provides a barrier to prevent leachate to groundwater and a mechanism for leachate collection. The Landfill was constructed without a bottom liner and leachate collections system; however, it has a well vegetated cover system of natural soil and stormwater collection infrastructure to direct uncontaminated stormwater off of the Landfill site.

Due to the presence of waste at elevations higher than the natural topography of the surrounding area, leachate mounding can also occur within the waste mass. Mounding has the potential to result in leachate seeps along embankments and side slopes. Leachate seeps may result in leachate migrating off-site with surface water run-off from the Landfill's cover system.

3.3.3 Landfill Gas

Another potential source of contamination comes from landfill gas. Landfill gas is produced by the breakdown of organic matter within the waste mass. Although landfill gas mainly consists of methane and carbon dioxide, it can also be comprised of non-methane organic compounds (NMOC). These compounds include VOCs, some of which have been identified as potential impacts to groundwater at the Landfill site. Further discussion on landfill gas is provided in Section 6 of NES Amendment No. 1.

3.4 POTENTIAL OFF-SITE SOURCES OF GROUNDWATER IMPACTS

Similar to landfills, industrial operations and urban environments are a source for groundwater and surface water contamination. To the south of the Landfill along Southlawn Lane is a heavy industrial area. Industrial operations located in proximity to the Landfill include general construction equipment storage and repair; concrete and asphalt manufacturing; and scrap metal recycling. In general, the area is considered urban in nature, and it includes both commercial and industrial operations. The residential areas are also considered fairly dense and themselves a potential source of contamination to groundwater and surface water. Further discussion on impacts to surface water is presented in Section 8.

3.4.1 Southlawn Lane and Gude Drive Industrial Area

The Landfill is bound to the southeast and southwest by a heavily industrial and commercial area. Industrial facilities often have operations which have the potential to result in runoff or point discharges. Utilizing EPA's My Environment tool (http://www.epa.gov/myenvironment/)[3], over two dozen industrial or commercial facilities were identified in just over a mile radius of the Landfill site. The list includes a scrap metal facility, commercial press and printing, heavy equipment rental, numerous automotive facilities and dry cleaners. Potential sources of impacts to groundwater via the infiltration of normal runoff conditions may include: salt, motor oil and fuels; chemicals used in manufacturing process (bonding agents, surfactants, etc.); metals; and trash.

3.4.2 Urban Environments

Urbanization has the potential to impact groundwater in the vicinity of the Landfill. In general terms, this includes potential impacts to groundwater from urban roadways, urban residential developments and recreational land use. Runoff from roads may include salts, motor oil and fuels, and trash, all of which may be present in surface water which can infiltrate the ground surface and potentially have some impact on groundwater. Likewise, these same potential contaminants may originate from urban residential developments. In particular, this groundwater contamination often consists of BTEX (benzene, toluene, ethylbenzene and xylene), which are common contaminants from petroleum products such as gasoline. Petroleum products from motor vehicles or other sources have the potential to infiltrate the subsurface and contaminate groundwater. Other contaminants introduced into the environment stem from residential dumping of household chemicals, as well as the use of pesticides and fertilizers by homeowners or where land use is recreational. These are less of a concern in rural environments, but are more of an issue in highly dense communities where their impacts can be exasperated. Although residential and commercial facilities are less likely to contribute to contamination in the vicinity of the Landfill, they may contribute to potential impacts to groundwater.

[3] Accessed October 30, 2011.

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4. EXTENT OF POTENTIAL IMPACTS TO GROUNDWATER

Investigations were performed in 2010 to determine the extent of potential impacts to groundwater from the Landfill; these results were included in the NES Report. Based on comments provided by MDE, additional investigations were performed as part of NES Amendment No. 1 to further define the extent of potential impacts to groundwater to the northwest, northeast, southeast and the southwest in the vicinity of the Landfill site. In accordance with the MDE Comment/County Response Document, Section 4 of this report provides the following:

- An updated groundwater contour map presented over a topographic map, which includes surface water elevations (from stream gauging activities) from bordering streams (Crabbs Branch and Southlawn Branch).
- Evaluation to reflect aspects of the Landfill's topography and the apparent flow direction of surface water bodies along the perimeter Landfill property boundary. Define more localized (e.g., radial) groundwater flow components of the Landfill site in an attempt to close the groundwater contours.
- Further evaluation and characterization of the extent of MCL exceedances through additional groundwater sampling and analyses in the following areas of the Landfill site: northwest, northeast, southwest and southeast.
- Further evaluation of the extent of potential impacts to groundwater and graphical depictions of constituents including metals that exceed individual groundwater protection standards. Impacts are presented at the single constituent level where groundwater protection standards are exceeded, with bounding of the potential extent of impacts.

4.1 GROUNDWATER FLOW DIRECTION

As part of the NES Amendment No. 1, fifteen (15) stream gauge locations (SG-1 to SG-15) were identified and the elevation of water within the stream was surveyed. The gauging of the stream elevations were performed in conjunction with depth to water measurements of all existing and new groundwater monitoring wells and TGWs by EA on August 30, 2011. The data presented in **Table 4-1** was utilized to refine the groundwater contour map (**Figure 4-1**) to reflect flow components of adjacent streams and define more localized groundwater flow components. Groundwater contours were overlaid onto a topographical map to incorporate topographic features that could influence groundwater patterns.

Findings

Similar to the findings of the NES Report, groundwater elevation data collected from the groundwater monitoring wells and stream gauge locations indicated an easterly flow direction across the Landfill, with minor north, northeasterly and southeasterly components. Stream gauge elevations were in agreement with groundwater table elevations from adjacent groundwater monitoring wells, indicating hydraulic connection between groundwater and surface water.

4.2 HORIZONTAL EXTENT OF IMPACTS

MCL exceedances for the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011) are presented in **Figure 4-2** through **Figure 4-6**. **Figure 4-2** provides an overview of MCL exceedances during the NES sampling event (July/August 2010), the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011) for both permanent and temporary groundwater monitoring wells. **Figures 4-3** through **4-6** provide focused presentations of MCLs for the following areas of, and in the vicinity of, the Landfill site: northwest (**Figure 4-3**), northeast (**Figure 4-4**), southeast (**Figure 4-5**) and southwest (**Figure 4-6**). As discussed in Section 3.1.1, dissolved (rather than total) concentrations were used to identify MCL exceedances for metals.

4.2.1 Northwest

The area to the northwest (**Figure 4-3**) of the Landfill includes Derwood Station residential development. Groundwater monitoring wells identified as being located in the northwest portion of the monitoring network (both permanent and temporary) include the following:

- Landfill Border Near Derwood Station
  - OB03, OB03A, MW-7 and MW-8
- Derwood Station
  - MW-9, MW-10, MW-11A, MW-11B, MW-12, MW-14A, MW-14B and MW-15
- Landfill Property Boundary and MNCPPC Property to the North
  - MW-13A, MW-13B, TGW-6, TGW-7, TGW-8 and TGW-9

During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), MCL exceedances occurred in three (3) of the four (4) groundwater monitoring wells that border the Landfill near Derwood Station residential development. Of the exceedances, nitrate exceeded the MCL (10 mg/L) in MW-7 (14.59 mg/L) and MW-8 (13.85 mg/L); TCE exceeded the MCL (5 µg/L) in OB03 (5.6 µg/L) and MW-7 (11 µg/L); and VC exceeded the MCL (2 µg/L) in OB03 (11 µg/L). The concentrations were generally lower than those reported during the NES sampling event (July/August 2010).

There were no MCL exceedances for the groundwater monitoring wells located within the Derwood Station residential development during the County semi-annual sampling event (April 2011). In MW-9, PCE was detected at the MCL (5 µg/L). BTEX components (benzene, toluene and xylene) were also detected at concentrations below MCLs in MW-9. During the NES sampling event (July/August 2010), PCE exceeded the MCL in MW-9 with a concentration of 14 µg/L.

PCE, as well as its degradation products (i.e., daughter products) TCE, DCE and VC, exceeded MCLs to the north of the site in MW-13A, along with 1,2-dichloropropane and methylene chloride. VC exceeded the MCL (2 µg/L) in TGW-6, located on M-NCPPC property south of Crabbs Branch stream. There were no MCL exceedances in temporary groundwater monitoring wells north of Crabbs Branch stream, indicating that Crabbs Branch stream acts as a hydraulic barrier. 1,2-Dichloropropane was used as an industrial solvent and is used in the production of PCE and other chlorinated solvents.[4] Methylene chloride is also used as an industrial solvent. The detection of industrial solvents indicate that they may have been disposed of at the Landfill.

Findings

The extent of potential impacts to groundwater from the Landfill extends slightly into the Derwood Station residential development in the vicinity of groundwater monitoring well MW-9, which is within several hundred feet of the Landfill. Additionally, potential impacts to groundwater exist to the very north of the Landfill site south of Crabbs Branch stream in both permanent and temporary groundwater monitoring wells. There were no MCL exceedances on the north side of Crabbs Branch stream, indicating that the Crabbs Branch stream acts as a hydraulic barrier.

[4] Agency For Toxic Substances & Disease Registry.
http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=162 . Accessed October 2011.

4.2.2 Northeast

The area to the northeast (**Figure 4-4**) of the Landfill includes only M-NCPPC park property. Monitoring locations identified as being located in the northeast portion of the monitoring network (both permanent and temporary) include the following:

- North Near Crabbs Branch Stream
  - OB102, OB04, OB04A and TGW-10
- Along Unnamed Tributary
  - OB105, OB06, OB07, OB07A
- Other
  - MW-1B, MW-2A and MW-2B

During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), MCL exceedances occurred at only one (1) of the groundwater monitoring wells to the northeast on M-NCPPC property. Near Crabbs Branch stream, methylene chloride, PCE and TCE exceeded MCLs in OB04A. There were no MCL exceedances in adjacent groundwater monitoring wells OB102 and OB04. The County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011) concentrations were generally higher than the NES sampling event (July/August 2010) concentrations.

Findings

The extent of potential impacts to groundwater from the Landfill extends slightly into M-NCPPC property in the vicinity of groundwater monitoring wells OB04 and OB04A, which are within approximately two hundred (200) feet of the Landfill. There were no other MCL exceedances within the adjacent M-NCPPC property, indicating that with the exception of the area surrounding OB04 and OB04A, the extent of potential impacts to groundwater from the Landfill is limited to the Landfill to the Northeast.

4.2.3 Southeast

The area to the southeast (**Figure 4-5**) of the Landfill includes groundwater monitoring wells on M-NCPPC park property, the Landfill property and WSSC property. Monitoring locations identified as being located in the southeast portion of the monitoring network (both permanent and temporary) include the following:

- M-NCPPC Property
  - MW-3A and MW-3B
- Landfill Property North of Southlawn Branch Stream, East of Incinerator Lane
  - OB08 and OB08A
- Landfill Property South of Southlawn Branch Stream, East of Incinerator Lane
  - OB10, MW-4, TGW-1
- Landfill Property North of Southlawn Branch Stream, West of Incinerator Lane
  - OB11, OB11A and OB025
- WSSC Property
  - TGW-2

During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), MCL exceedances were reported for three (3) of the groundwater monitoring wells located to the southeast of the Landfill. On Landfill property, south of Southlawn Branch stream and east of Incinerator Lane, the reported TCE concentration exceeded the MCL (5 µg/L) in MW-4. There were no MCL exceedances in nearby groundwater monitoring well OB10 or in TGW-1. MW-4 is located south of Southlawn Branch stream and may be impacted by other industrial sources in the vicinity of the Landfill. However, the topography of the area indicates that any potential impact to the groundwater from the Landfill would likely be localized. The County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011) concentrations were generally less than the NES sampling event (July/August 2010) concentrations.

On the Landfill property, north of the Southlawn Branch stream and west of Incinerator Lane, MCLs were exceeded in OB11 and OB11A. The reported concentrations of PCE and its degradation products (i.e., daughter products) TCE, DCE and VC exceeded MCLs in OB11A. MCL exceedances in OB11 included 1,1-DCE, 1,2-dichloropropane, benzene, methylene chloride, PCE, TCE and VC. The dissolved fraction of cadmium also exceeded the MCL (0.005 mg/L) at a concentration of 0.016 mg/L. There were no MCL exceedances in adjacent groundwater monitoring well OB025 or in TGW-2 located just south of Southlawn Branch stream in the vicinity of OB11/OB11A, indicating that the Southlawn Branch stream acts as a hydraulic barrier.

Findings

The extent of potential impacts to groundwater from the Landfill does not extend beyond the current Landfill property boundary to the southeast. All MCL exceedances, with the exception of TCE at MW-4, are present on the north (Landfill side) of Southlawn Branch stream, indicating that the Southlawn Branch stream acts as a hydraulic barrier. The extent of potential impacts to groundwater from the Landfill to the southeast of MW-4 is not bounded by the Southlawn Branch stream; however, the topography of the area indicates that the potential impacts to groundwater are likely localized.

4.2.4 Southwest

The area to the southwest (**Figure 4-6**) of the Landfill includes wells on the Landfill property and WSSC property. Groundwater monitoring wells identified as being located in the southwest portion of the monitoring network (both permanent and temporary) include the following:

- WSSC Property North of Southlawn Branch Stream
  - OB12, OB015 and TGW-5
- WSSC Property South of Southlawn Branch Stream
  - TGW-3 and TGW-4
- Landfill Property Near Derwood Station
  - OB02 and OB02A
- Landfill Property Near Landfill Gas to Energy Facility
  - MW-6 and OB01

During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), MCL exceedances occurred in two (2) of the groundwater monitoring wells located to the southwest of the Landfill. The wells with MCL exceedances were OB12 and TGW-5, both located on WSSC property north of the Southlawn Branch stream. The reported concentrations of PCE, TCE and methylene chloride exceeded MCLs in OB12. The reported concentrations of TCE and VC exceeded MCLs in TGW-5. No other permanent or temporary groundwater monitoring wells in this area exceeded MCLs. The County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011) concentrations were generally less than the NES sampling event (July/August 2010) concentrations.

Findings

The extent of potential impacts to groundwater from the Landfill extends beyond the Landfill property boundary into WSSC property in the vicinity of permanent groundwater monitoring well OB12 and temporary groundwater monitoring well TGW-5, located north of Southlawn Branch stream (Landfill side). There were no MCL exceedances on the south side of Southlawn Branch stream in temporary groundwater monitoring wells, indicating that the Crabbs Branch stream acts as a hydraulic barrier.

4.2.5 Spatial Distribution of MCL Exceedances

The NES Report presented the spatial distribution of total VOC concentrations across the site with an isoconcentration map. Per MDE's comments, as part of NES Amendment No. 1, maps have been prepared that present the spatial distribution of MCL exceedances on an individual constituent basis for the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011). These MCL Compliance Extent Maps are presented as **Figures 4-7** through **4-17**. Note that the exceedance extent line was drawn to the nearest location where the result was "non-detect", which may or may not coincide with the site features (e.g., streams, topography, etc.) that act as barriers to contamination migration in groundwater. The following summarizes the spatial distribution for each of the constituents:

- ***1,1-DCE*** **–** Historically, this constituent has only been detected at concentrations less than the MCL (7 µg/L) in groundwater monitoring wells OB03, OB03A, OB10, OB11 and OB11A at low to trace concentrations. During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011) it was only detected in OB01 (1.1 µg/L), which is a first time detection, and OB11 (25 µg/L). As a result, the map (**Figure 4-7**) illustrates limited spatial data associated with the contaminant. There is one area (south of OB11) where the inferred extent of potential MCL exceedance extends beyond the Landfill property boundary; however, the non-detect result at TGW-2 indicates that the Southlawn Branch stream acts as a hydraulic barrier to prevent further migration of this contaminant.
- ***1,2-Dibromoethane*** **–** Similarly to 1,1-DCE, this exceedance is not consistent with historical data. 1,2-Dibromoethane was a first time detection and a first time MCL exceedance for OB11A. There were no other detections. The only other historical detection was in surface water sample ST015 during the April 2006 sampling event. As a result, the map (**Figure 4-8**) illustrates limited spatial data associated with the contaminant. There is one area (south of OB11) where the inferred extent of potential

MCL exceedance extends beyond the Landfill property boundary; however, the non-detect result at TGW-2 indicates that the Southlawn Branch stream acts as a hydraulic barrier to prevent further migration of this contaminant.

- ***1,2-Dichloropropane* –** Historically, this constituent has exceeded MCLs in groundwater monitoring wells MW-13A, MW-13B, OB03, OB03A, OB08A, OB11, OB11A and OB12. During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), detections were limited to the most northern part of the site and along the southern boundary of the site and are presented in **Figure 4-9**. There are two areas (north of MW-13A and south of OB11) where the inferred extent of potential MCL exceedance extends beyond the Landfill property boundary; however, the non-detect results at TGW-7, 8, 9 and TGW-2 indicate that the Crabbs Branch and Southlawn Branch streams act as hydraulic barriers to prevent further migration of this contaminant.
- ***Benzene* −** Historically, this constituent has exceeded MCLs in groundwater monitoring wells MW-13B, OB03, OB03A, OB08A, OB11 and OB11A. During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), detections were limited to the most northern part of the site and along the southern boundary of the site and are presented in **Figure 4-10**. There is one area (south of OB11) where the inferred extent of potential MCL exceedance extends beyond the Landfill property boundary; however, the non-detect result at TGW-2 indicates that the Southlawn Branch stream acts as a hydraulic barrier to prevent further migration of this contaminant.
- ***Cadmium, dissolved* –** Due to high turbidity, total metals exceedances have sporadically occurred at the Landfill site. Total metals concentrations are not considered representative of actual groundwater conditions and therefore were not evaluated further. During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), one (1) detection of dissolved cadmium was reported, at groundwater monitoring well OB11, located along the southern boundary of the Landfill site (**Figure 4-11)**. The inferred extent of potential MCL exceedance extends beyond the Landfill property boundary; however, the non-detect result at TGW-2 indicates that the Southlawn Branch stream acts as a hydraulic barrier to prevent further migration of this contaminant.
- ***Cis-1,2-DCE*** − Historically, this constituent has exceeded MCLs in groundwater monitoring wells MW-13A, MW-13B, OB02A, OB03, OB03A, OB08A, OB10, OB11 and OB11A. During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), detections were limited to the most

northern part of the site and along the southern boundary of the site and are presented in **Figure 4-12**. There are two areas (north of MW-13A and south of OB11) where the inferred extent of potential MCL exceedance extends beyond the Landfill property boundary; however, the non-detect results at TGW-7, 8, 9 and TGW-2 indicate that the Crabbs Branch and Southlawn Branch streams act as hydraulic barriers to prevent further migration of this contaminant.

- ***Methylene Chloride*** − Historically, this constituent has exceeded MCLs in groundwater monitoring wells MW-13A, MW-13B, OB03A, OB04A, OB08A, OB10, OB11, OB11A and OB12. During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), detections were identified in the northern part of the site and along the southern boundary near WSSC property and are presented in **Figure 4-13**. There are two areas (north of MW-13A and east of OB04A, and south of OB11 and OB12) where the inferred extent of potential MCL exceedance extends beyond the Landfill property boundary; however, the non-detect results at TGW-6,7, 8, 9, 10 and TGW-2, 3, 4, 5 indicate that the Crabbs Branch and Southlawn Branch streams act as hydraulic barriers to prevent further migration of this contaminant.
- ***Nitrate*** **–** Per the request of MDE, leachate indicator parameters were added to the County DEP's monitoring program during the September 2010 sampling event performed by County DEP. During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), detections were observed to the most northern part of the Landfill site, along the northwest property boundary, in the Derwood Station residential development and along the southern property boundary near the Landfill Gas to Energy Facility and WSSC property (**Figure 4-14**). Detections in the groundwater monitoring wells were low, with the exception of MW-7 and MW-8 where concentrations exceeded the MCL. The inferred extent of potential MCL exceedance extends beyond the Landfill property boundary in the area of MW-7 and MW-8; however, the lower results in groundwater monitoring wells below MCLs throughout the Derwood Station residential development (MW-9, MW-10, MW-11A, MW-11B, MW-12, MW-14A, MW-14B and MW-15) indicate that the extent of the MCL exceedance area is limited.
- ***PCE*** − Historically, this constituent has exceeded MCLs in groundwater monitoring wells MW-9, MW-13A, MW-13B, OB02A, OB03, OB03A, OB04A, OB08, OB08A, OB10, OB11, OB11A and OB12. During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), detections occurred throughout the groundwater monitoring network, with the exception of the southeast portion of the Landfill site (**Figure 4-15)**. There are three areas (north of

MW-9, north of MW-13A and east of OB04A, and south of OB11, OB12 and TGW-5) where the inferred extent of potential MCL exceedance extends beyond the property boundary; however, the non-detect results at TGW-7, 8, 9 and TGW-2, 3, 4 and 5 indicate that the Crabbs Branch and Southlawn Branch streams act as hydraulic barriers to prevent further migration of this contaminant. In the Derwood Station residential development, the non-detect results at groundwater monitoring wells (MW-9, MW-10, MW-11A, MW-11B, MW-12, MW-14A, MW-14B and MW-15) throughout indicate that the extent of the MCL exceedance area is limited.

- ***TCE*** − Historically, this constituent has exceeded MCLs in groundwater monitoring wells MW-4, MW-7, MW-13A, MW-13B, OB01, OB02, OB02A, OB03, OB03A, OB04A, OB08, OB08A, OB10, OB11, OB11A, OB12 and TGW-5. During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), detections occurred throughout the groundwater monitoring network, with the exception of M-NCPPC property to the northeast and within Derwood Station residential development (**Figure 4-16)**. There are four areas (north of MW-7 and OB03, north of MW-13A and east of OB04A, south of OB11, OB11A, OB12 and TGW-5, and southeast of MW-4) where the inferred extent of potential MCL exceedance extends beyond the Landfill property boundary; however, the non-detect results at TGW-7, 8, 9 and TGW-2 and 4 indicate that the Crabbs Branch and Southlawn Branch streams act as hydraulic barriers to prevent further migration of this contaminant. In the Derwood Station residential development, the non-detect results in groundwater monitoring wells (MW-9, MW-10, MW-11A, MW-11B, MW-12, MW-14A, MW-14B and MW-15) throughout indicate that the extent of the MCL exceedance area is limited. The extent of MCL exceedance area to the southeast of MW-4 is not bounded by the Southlawn Branch stream; however, the topography of the area indicates that the exceedance may be localized.
- ***VC*** − Historically, this constituent has exceeded MCLs in groundwater monitoring wells MW-6, MW-7, MW-13A, MW-13B, OB01, OB105, OB025, OB02A, OB03, OB03A, OB04, OB04A, OB08A, OB10, OB102, OB105, OB11, OB11A, OB12, TGW-5 and TGW-6. During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), detections were limited to the most northern part of the site and along the southern boundary near WSSC property and are presented in **Figure 4-17**. There are two areas (north of OB03 and west of TGW-6 and MW-13A, and south of OB11, OB11A and TGW-5) where the inferred extent of potential MCL exceedance extends beyond the Landfill property boundary; however, the non-detect results at TGW-7, 8, 9 and TGW-2, 3, 4 indicate that the Crabbs Branch and

Southlawn Branch streams act as hydraulic barriers to prevent further migration of this contaminant. In the Derwood Station residential development, the non-detect results at groundwater monitoring wells (MW-9, MW-10, MW-11A, MW-11B, MW-12, MW-14A, MW-14B and MW-15) throughout indicate that the extent of the MCL exceedance area is limited.

Findings

In general, potential impacts to groundwater (MCL exceedances) from the Landfill mainly consist of VOCs, in particular chlorinated solvents. The extent of MCL exceedances is beyond the Landfill property boundary for several constituents in several areas. These areas include the Derwood Station residential development, M-NCPPC property and WSSC property. The presence of streams and topographic features act as natural hydraulic barriers to contamination migration in groundwater.

4.4 VERTICAL EXTENT OF IMPACTS

As discussed in the NES Report, subsurface geology varies, but generally consists of unconsolidated sediments and bedrock. The groundwater table is typically present in the unconsolidated sediments along the perimeter of the Landfill and under the Derwood Station residential development, at depths ranging from approximately three (3) to sixty (60) feet (ft) below ground surface (bgs).

Table 4-2 summarizes the vertical extent of MCL exceedances for the NES sampling event (July/August 2010), the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011).

- ***Northwest*** − The area to the northwest of the Landfill includes the Derwood Station residential development. MCL exceedances were reported in eight (8) groundwater monitoring wells (MW-7, MW-8, MW-9, MW-13A, MW-13B, OB03, OB03A and TGW-6) during the NES sampling event (July/August 2010), the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), with screened well depths ranging from two (2) to one hundred fifty-four (154) ft bgs (elevation range two hundred fifty-three [253] to four hundred thirteen [413] ft).
- ***Northeast*** − The area to the northeast of the Landfill includes only M-NCPPC park property. MCL exceedances were reported in one (1) groundwater monitoring well

(OB04A) during the NES sampling event (July/August 2010), the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), with a screened well depth ranging from thirty-three (33) to eighty-three (83) ft bgs (elevation range two hundred seventy-nine [279] to three hundred twenty-nine [329] ft).

- ***Southeast*** − The area to the southeast of the Landfill includes groundwater monitoring wells on M-NCPPC park property, the Landfill property and WSSC property. MCL exceedances were reported in seven (7) groundwater monitoring wells (MW-4, OB08, OB08A, OB10, OB11 and OB025) during the NES sampling event (July/August 2010), the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), with screened well depths ranging from five (5) to one hundred fifty-four (154) ft bgs (elevation range one hundred sixty-eight [168] to three hundred fifty-four [354] ft).
- ***Southwest*** − The area to the northwest of the Landfill includes the Derwood Station residential development. MCL exceedances were reported in five (5) groundwater monitoring wells (MW-6, OB01, OB12, OB015 and TGW-5) during the NES sampling event (July/August 2010), the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), with screened well depths ranging from three (3) to seventy-five (75) ft bgs (elevation range three hundred thirty-eight [338] to four hundred ten [410] ft).

Findings

Based on the NES sampling event (July/August 2010), the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), MCL exceedances were observed at the greatest frequency in OB11, OB11A, OB03 and MW-13A. However, the vertical extent of MCL exceedances were observed in various groundwater monitoring wells ranging in screen depths from two (2) to one hundred fifty-four (154) ft bgs, mostly screened within bedrock.

4.5 SITE FEATURE BARRIERS

In accordance with the MDE Comment/County Response Document, EA collected supplemental information to determine the hydraulic relationship between groundwater and the surface water bodies along the northern and southern Landfill boundaries.

Groundwater elevation and stream elevation data collected on August 30, 2011 from temporary groundwater monitoring wells (TGW-1 through TGW-10) and the stream gauge locations (SG-1 through SG-15) demonstrate a close relationship between groundwater and stream elevations along Crabbs Branch and Southlawn Branch streams. As indicated on **Table 4-1** and the Inferred Contoured Groundwater Elevation Map provided as **Figure 4-1**, the stream elevations correlate extremely well with groundwater elevations collected from nearby groundwater monitoring wells. This close relationship indicates that the shallow groundwater and bordering streams are likely interconnected and that the streams are gaining some amount of water from the shallow groundwater. Deeper groundwater flow paths may be influenced by the streams, but it is not known to what degree, if any, deeper groundwater is captured by the streams.

Under natural conditions, groundwater makes some contribution (baseflow) to streamflow in most physiographic and climatic settings. The contribution of baseflow from the groundwater to Crabbs Branch stream along the northern Landfill boundary and Southlawn Branch stream along the southern boundary is further demonstrated by the analytical results obtained during this investigation. As indicated on **Table 3-1**, the groundwater samples collected from OB11, OB11A, MW-13A, TGW-5 and TGW-6 located on the Landfill side of the streams contained chemical concentrations above MCLs. Constituent concentrations were not detected above MCLs in temporary monitoring wells TGW-2, TGW-4, TGW-7 and TGW-8, immediately across the streams. This concept is most easily observed on the MCL Exceedances Map attached as **Figure 4-2**.

<u>Findings</u>

In summary, supplemental groundwater elevation, stream elevation and groundwater analytical data were collected from the stream gauges and temporary groundwater monitoring wells along Crabbs Branch and Southlawn Branch streams. The data demonstrates that the streams are limiting the migration of constituents in shallow groundwater from the Landfill; however, deeper groundwater flow paths may be influenced by the streams, but it is not known to what degree, if any, deeper groundwater is captured by the streams.

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5. LANDFILL SURFACE HYDROLOGY

In accordance with the MDE Comment/County Response Document, County DEP in conjunction with EA has prepared a summary discussion regarding the site features and topography, stormwater drainage infrastructure and stormwater diversion that influence surface hydrology at the Landfill. Specifically, this discussion focuses on the way in which the Landfill's topography and existing stormwater drainage structures minimize standing water (e.g., ponding) and infiltration into the waste mass.

5.1 SITE FEATURES AND TOPOGRAPHY

The Landfill property is approximately one hundred sixty-two (162) acres in size with an estimated waste disposal footprint of one hundred (100) acres. There are approximately sixteen and a half (16.5) acres of waste encroachment on M-NCPPC property. The depth of waste varies across the site from approximately fifty-five (55) to ninety (90) ft. The surrounding area and property border of the Landfill is primarily mixed use: industrial operations (east by southeast); WSSC property and E. Gude Drive (south); a Transcontinental/Columbia Gas natural gas pipeline right-of-way and the community of Derwood Station South (west); and M-NCPPC land (north by northeast). The Landfill is also bordered by surface water bodies: Crabbs Branch stream (north by northeast) and Southlawn Branch stream (south by southeast).

The site topography is plateau-like and consists of gentle relief (i.e., slope) along the top of the waste-mass and sharp relief along the Landfill boundary. The elevation along the top of the plateau gently slopes to the south, with localized mounds and depressions throughout. The side slope falls sharply from the top of the waste-mass to elevations ranging from fifty-five (55) to ninety (90) ft below the plateau. The Landfill surface generally consists of well-vegetated open grassy fields with portions of the site covered by sporadic patches of trees.

A general summary of approximate topographic elevations across the Landfill site taken to the toe of slope of the waste mass and/or drainage areas as applicable (including the waste encroachment property of M-NCPPC that County DEP is in the process of acquiring) are provided below:

- Plateau – elevation range 470 to 450 ft (top of landfill)
- Northwest – elevation range 425 to 410 ft (toe of slope along Gas Right-of-Way)

- North – elevation range 385 to 365 ft (toe of slope along Crabbs Branch stream)
- Northeast – elevation range 385 to 375 ft (toe of slope along M-NCPPC land)
- Southeast – elevation range 370 to 340 ft (toe of slope along M-NCPPC land Southlawn Branch stream)
- South – elevation range 425 to 360 ft (toe of slope along WSSC land and Southlawn Branch stream)
- Southwest – elevation range 425 to 410 ft toe of slope along County land and Gas Right-of-Way)

A topographic map (based on the 2009 Survey) that presents such site features and conditions at the Landfill was included in the NES Report, Appendix A, Attachment 6 – Technical Memorandum, Waste Delineation, Figure 1 – Gude Landfill Waste Delineation.

5.2 STORMWATER DRAINAGE INFRASTRUCTURE

As part of the initial NES site investigations, EA and its Subcontractor inventoried, inspected and surveyed all stormwater drainage structures at the Landfill. The inventory included existing swales, berms, inlet structures, outlet structures, culverts, detention ponds and sediment basins. A total of one hundred three (103) stormwater structures were located and assessed in the field. A site map presenting the locations of the stormwater structures was included in the NES Report, Appendix A, Attachment 3 – Technical Memorandum, Stormwater Infrastructure Review, Figure 3-2 – Stormwater Structure Location Map.

Detailed summaries of historical site improvements to the cover system (including leachate seep and ponding water repairs) and stormwater drainage structures at the Landfill were also included in the NES Report, Section 1.4 – Best Management Practices at the Landfill, Pages 9-10 and 13; Appendix A, Attachment 1 – Technical Memorandum, Post-Closure Care Monitoring and Maintenance; and Appendix A, Attachment 3 – Technical Memorandum, Stormwater Infrastructure Review.

A general summary of the direction of surface water runoff from the Landfill site is provided below:

- Plateau – flow oriented to the south/south east
- Northwest – flow oriented to Gas Right-of-Way
- North – flow oriented to Crabbs Branch stream

- Northeast – flow oriented to M-NCPPC land
- Southeast – flow oriented towards M-NCCPC land and Southlawn Branch stream
- South – flow oriented towards WSSC land and Southlawn Branch stream
- Southwest – flow oriented towards Pond No. 1

5.3 STORMWATER DIVERSION

With respect to post-closure care of the Landfill, active stormwater diversion requires maintenance of the cover system; drainage collection and conveyance structures for discharges on- and off-site; and prevention of potential stormwater pollutant (i.e., non-stormwater) discharges. With the above referenced improvements to the Landfill's cover system and drainage network, County DEP in conjunction with its operational Contractors have been actively diverting stormwater off of the Landfill surface from 1984 to present. These improvements have also helped to reduce the potential for stormwater infiltration through the cover system and into the waste mass, thus reducing the potential to generate leachate that would further impact groundwater.

A site map that correlates the current topography, as-built documents, surveyed stormwater infrastructure and surface runoff (e.g., stormwater) catchment areas and flow directions across the Landfill was included in the NES Report, Appendix A, Attachment 3 – Stormwater Infrastructure Review, Figure 3-3 – Drainage Area Map. The drainage area boundaries were delineated based upon the contours and surface features collected in the 2009 topographic survey. Drainage areas were also delineated to stormwater structures where contours indicated flow concentrations. Some drainage areas on the cover system are captured and conveyed by storm drains that then discharge further down gradient at the Landfill perimeter or into another drainage area. Areas where runoff is conveyed by stormwater infrastructure are indicated by a bold arrow.

Overall, the Drainage Area Map provides documentation to support County DEP's implementation of active stormwater diversion techniques and best management practices for a pre-regulatory era (RCRA) landfill. For further information, refer to NES Report, Appendix A, Attachment 3.

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6. LANDFILL GAS MANAGEMENT AND GROUNDWATER QUALITY

In accordance with the MDE Comment/County Response Document, County DEP in conjunction with EA has prepared an evaluation to quantify the potential benefits that active landfill gas management has on groundwater quality at the Landfill.

6.1 SUMMARY OF LANDFILL GAS MANAGEMENT

County DEP in conjunction with its operational Contractors has been actively managing landfill gas at the Landfill from 1985 to present. A detailed history of landfill gas management activities is included in the NES Report, Section 1.4 – Best Management Practices at the Landfill, Pages 10-12 and in Appendix A, Attachment 2 – Technical Memorandum, Landfill Gas Management Chronology.

In addition to the landfill gas management system improvements identified in the above referenced sections of the NES Report, DEP has continued to implement measures to further enhance landfill gas collection. From December 13th, 2010 to January 5th, 2011, County DEP's operational Contractor, SCS Engineers, installed twenty-one (21) new landfill gas extraction wells (EW-133 to EW-153) and five (5) dewatering sumps (DS-1 to DS-5). These measures have effectively reduced landfill gas migration along targeted portions of the northwest and southern property boundaries of the Landfill.

6.2 RELATIONSHIP OF LANDFILL GAS AND GROUNDWATER QUALITY

The composition of landfill gas is unique to each landfill, which directly correlates to the actual composition and decomposition of the waste mass. Generally, landfill gas is comprised of approximately 45-55 percent methane and 40-50 percent carbon dioxide. The balance is typically made up of oxygen, nitrogen, hydrogen sulfide and numerous other trace constituents such as NMOCs. The NMOCs are a list of complex organic compounds, which includes VOCs as a subset. VOCs are often found as constituents in landfill leachate, which are monitored in the groundwater on and in the vicinity of landfills. Thus, if VOCs are detected in groundwater, there exists a potential relationship between landfill gas management and groundwater quality.

6.3 EVALUATION OF CONSTITUENTS IDENTIFIED IN LANDFILL GAS AND GROUNDWATER

To establish the potential relationship between landfill gas management and groundwater quality at the Landfill, the results of the following two (2) previously prepared analyses were compared:

- ***Sampling and Analysis for Landfill Gas*** **–** was performed by SCS Engineers in February 2008 on behalf of the County Division of Solid Waste Services in accordance with EPA Method TO-15 for VOCs in air for the Landfill.
- ***Sampling and Analysis for Groundwater and Surface Water*** **–** was performed by the County DEP in April 2011 in accordance with the Groundwater and Surface Water Monitoring Plan (Semi-Annual Sampling Event) and analytical constituents of Tables I and II (includes VOCs) for the Landfill.

Table 6-1 presents the constituent detections that were identified in both of the above referenced landfill gas and groundwater analyses. Constituent concentrations found in landfill gas were converted from micrograms per cubic meter ($\mu g/m^3$) of air to parts per billion (ppb), which is a standard unit of measure for groundwater analyses.

A total of fifteen (15) constituents were identified in landfill gas that had detections in groundwater at the Landfill. Of the identified constituents, seven (7) constituents also exceeded MCLs in groundwater, which included: 1,2-dichloropropane, benzene, cis-1,2-DCE, methylene chloride, PCE, TCE and VC.

6.4 POTENTIAL BENEFITS OF ACTIVE LANDFILL GAS MANAGEMENT ON GROUNDWATER QUALITY

The landfill gas management and collection system at the Landfill operates on a full-time (24/7/365) basis with the exception of weather-related outages and properly sequenced maintenance activities. The properly sequenced maintenance activities help to alternate downtime between the Landfill Gas Enclosed Ground Flares and the Landfill Gas-to-Energy Facility to ensure continuous landfill gas collection at the Landfill. The average flow of the landfill gas management and collection system at the Landfill is approximately eight hundred (800) standard cubic feet per minute (SCFM) with a methane content range of 35-45 percent.

Based on the correlation of constituents identified in landfill gas and groundwater, County DEP's active landfill gas management and collection system at the Landfill has been providing benefits to groundwater quality on a full-time continuous basis for approximately twenty-seven (27) years by removing the potential for the fifteen (15) constituents (at the relative concentrations) noted in **Table 6-1** to condense and enter into the groundwater at and in the vicinity of the Landfill. There is also a similar realized benefit from the gas management and collection system with respect to the decreased potential to emit green house gases (methane and carbon dioxide) at the Landfill. With respect to the control of constituent concentrations found in landfill gas and associated emissions, the two (2) Landfill Gas Enclosed Ground Flares have a destruction efficiency of approximately 98-99 percent for VOCS and the Landfill Gas-to-Energy Facility has destruction efficiency of 97-99 percent for VOCs.

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7. HUMAN HEALTH AND ECOLOGICAL RISK EVALUATIONS

As part of the NES Report, the County in conjunction with EA conducted Human Health and Ecological Risk Evaluations. The Risk Evaluations are not typical submissions in an NES Report; however, they were conducted to identify any potential adverse impacts to human and ecological health resulting from the potential risk COCs (e.g., contamination) originating from the Landfill site. The Risk Evaluations were pertinent to County DEP's relationship and on-going dialog with the Gude Landfill Concerned Citizens (GLCC) advisory group and the Derwood Station Residential Development.

Provided below is a summary of the NES Risk Evaluations and a Supplemental Risk Evaluation Review. The Supplemental Risk Evaluation Review evaluates new analytical (i.e., groundwater) data obtained through Amendment No. 1 investigations and confirms whether results are within the same range of previously evaluated contaminant thresholds for human health and ecological risk.

7.1 SUMMARY OF NES RISK AND SUPPLEMENTAL EVALUATIONS

The Risk Evaluations used analytical data obtained from the following media located on and in the vicinity of the Landfill: (1) groundwater, (2) surface water, (3) surface soil and (4) subsurface soil. Conceptual site models (CSMs) were then developed to identify potential exposure pathways and potential receptors (e.g., humans and wildlife) that may come into contact with the above referenced media currently and in the future. Exposure pathways were identified that may link potential receptors to potential risk-based COCs detected on and in the vicinity of the Landfill. Migration pathways were evaluated to determine complete exposure pathways for potential receptors. Only exposure pathways that are complete are included in the Risk Evaluations. Incomplete exposure pathways do not result in actual exposure of receptors.

The conclusions of the Risk Evaluations of the four (4) media types are summarized below:

- Groundwater
  - No human health or ecological concerns related to contact with groundwater water. The only potential human health concern identified related to groundwater would be present if the aquifer were used as a potable water supply, currently an incomplete exposure pathway. Water is supplied to the community by WSSC, and the installation of potable water supply wells is prohibited by WSSC.

- No human health concerns related to indoor air inhalation of VOCs following vapor intrusion from groundwater
- Surface water
  - No human health or ecological concerns related to contact with surface water.
- Surface Soil
  - No human health or ecological concerns related to contact with surface soil.
- Subsurface Soil
  - No human health or ecological concerns related to contact with subsurface soil.

The complete Risk Evaluations are included in Section 6 of the NES Report. The Risk Evaluations were conducted in accordance with MDE and EPA guidance (NES Report References – MDE 2008, EPA 2010, EPA 1989).

7.1.1 Supplemental Risk Evaluation Review

Analytical data were reviewed for the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011) and screened in accordance with the screening performed as part of the NES Report. Analytical data from the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011) were only screened for human health concerns since ecological receptors are not expected to have contact with groundwater. Groundwater analytical results from the groundwater monitoring wells within the Landfill monitoring network indentified risk-based COCs with concentrations that are consistent historical analytical results, including the NES sampling event (July/August 2010). Groundwater analytical results within Derwood Station residential development indicate a reduction in the number of risk-based COCs and the concentrations of risk-based COCs. Furthermore, no VOCs are considered COCs from a risk standpoint within the Derwood Station residential development. As noted in the NES Report, vapor intrusion of VOCs into indoor air is the only complete exposure pathway for residents in Derwood Station residential development. The County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011) indicated no VOCs as risk-based COCs because the concentrations are less than the level of concern for human health within the Derwood Station residential development.

Findings

As noted in the NES Report, vapor intrusion of VOCs into indoor air is the only complete exposure pathway for residents in Derwood Station residential development. The County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011) indicated no VOCs as risk-based COCs because the concentrations are less than the level of concern for human health within the Derwood Station residential development. Therefore, there are no human health concerns for residents' exposure to VOCs in groundwater within Derwood Station residential development.

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8. POTENTIAL IMPACTS TO SURFACE WATER

In accordance with the MDE Comment/County Response Document, County DEP in conjunction with EA has prepared a summary discussion regarding the potential impacts to surface water from the Landfill site and the adjacent land uses of the Landfill. No further field investigations or database searches were conducted.

8.1 POTENTIAL LANDFILL RELATED IMPACTS TO SURFACE WATER

As discussed in NES Amendment No. 1, Section 5, the County has maintained and improved the Landfill's cover system and drainage network since 1984 to actively divert clean stormwater runoff from the Landfill surface. County DEP has also implemented best management practices for post-closure care with the repair of areas experiencing leachate seeps and ponding water at the Landfill. These site management practices and infrastructure improvements have helped to minimize the potential for non-stormwater discharges off of the Landfill site, which has protected the adjacent receiving surface water bodies of Crabbs Branch stream and Southlawn Branch stream.

County DEP has also monitored surface water quality at and in the vicinity of the Landfill since 1984. Of the more than thirteen thousand (13,000) constituents analyzed from all surface water samples collected historically (May 2001 to September 2010) in streams near the Landfill, thirteen (13) exceedances of MCLs have been reported. In addition, EA's analyses as part of the NES Report indicated that the three (3) organic constituents (PCE, TCE and cis-1,2-dichloroethene) and two (2) metals (barium and nickel) detected in surface water were less than MDE Cleanup Standards for Groundwater, the criteria used to screen surface water. The only metal constituent that exceeded the cleanup standard was cobalt, which was found in concentrations in the same order of magnitude as background levels for soil. The Human Health and Ecological Risk Evaluations of the NES Report concluded that the concentrations of organic constituents and metals found in the surface water do not represent exposure risks to humans and aquatic organisms. The complete Risk Evaluations are included in the NES Report, Section 6 – Risk Evaluation.

Based on the above referenced information and as confirmed in the MDE Comment/County Response Document, the Landfill is not adversely impacting adjacent surface water bodies and no further assessments on potential surface water impacts from or in the vicinity of the Landfill are required at this time.

8.2 POTENTIAL ADJACENT LAND USE RELATED IMPACTS TO SURFACE WATER

As previously discussed, the adjacent land surrounding the Landfill is mixed use. The particular land uses that may pose potential impacts to the bordering surface water bodies of the Landfill include: urban roadways, urban residential development, recreational and heavy industry. A general summary of these land uses and potential sources of impact are provided below:

- ***Urban Roadways*** **–** there are two (2) heavily traveled roadways located in proximity to the Landfill and Southlawn Branch stream. With normal day-to-day traffic, potential sources of impacts to surface water through normal runoff conditions may include: loading of sediment, salt, motor oil and fuels; and trash.
- ***Urban Residential Development*** **–** there are several neighboring residential developments located in proximity to the Landfill and Crabbs Branch stream. Potential sources of impacts to surface water may include: loading of sediment, salt, motor oil and fuels; pesticides, herbicides and fertilizers; and trash.
- ***Recreational*** **–** there is a golf course located in proximity to the Landfill and Crabbs Branch stream. Potential sources of impacts to surface water through normal runoff conditions may include: loading of organics (grass cuttings); and pesticides, herbicides and fertilizers.
- ***Heavy Industry*** **–** there are a number of heavy industrial operations located in proximity to the Landfill and South Branch stream, which include general construction equipment storage and repair; concrete and asphalt manufacturing; and scrap metal recycling. Potential sources of impacts to surface water through normal runoff conditions may include: loading of sediment, salt, motor oil and fuels; chemicals used in manufacturing process (bonding agents, surfactants, etc.); metals; and trash.

Through the infiltration of surface water into the ground surface, the potential exists for the above referenced land uses to impact localized groundwater. Although these adjacent properties and associated land uses are not regulated through MDE solid waste post-closure care requirements for the Landfill, County DEP does enforce applicable federal, state and local stormwater regulations on a County-wide basis. County DEP stormwater management requirements and pollutant thresholds are stipulated under the County's NPDES Municipal Separate Storm Sewer System (MS4) Permit, which is administered by MDE.

9. SUMMARY OF FINDINGS

In general, the results of the NES Amendment No. 1 support the findings of the NES Report. The NES Amendment No. 1 further defines the nature and extent of potential impacts to groundwater from the Landfill, provides clarification on metals exceedances and addresses MDE comments on landfill surface hydrology, landfill gas management, human health and ecological risk evaluations, and potential impacts to surface water. Section 9 provides a summary of the findings from the NES Amendment No. 1 investigations and evaluations.

9.1 NATURE OF POTENTIAL IMPACTS TO GROUNDWATER

VOCs and metals have historically exceeded MCLs for samples collected and analyzed from several groundwater monitoring wells at the Landfill. NES Amendment No. 1 further evaluates and defines the nature of potential impacts to groundwater.

9.1.1 Groundwater Monitoring Data

Groundwater monitoring data evaluated as part of the NES Amendment No. 1 consists of two (2) additional groundwater sampling events: the County semi-annual sampling event (April 2011) performed by County DEP and the NES Amendment No. 1 sampling event (September 2011) performed by EA. Analyses for typical leachate indicator parameters were completed during the County semi-annual event (April 2011), as well as for monitoring locations installed and sampled by EA as part of additional NES Amendment No. 1 investigations (September 2011). Additionally, metals exceedances were further evaluated (using field filtration of samples) to discern the presence of metals dissolved in groundwater versus the fraction present within sediment suspended in groundwater during the sampling process. During the two (2) additional groundwater sampling events, the following eleven (11) constituents exceeded MCLs (metals – 1, VOCs – 9 and leachate indicator parameters – 1):

- Cadmium, dissolved – 1 location
- 1,1-Dichloroethene (DCE) – 1 location
- 1,2-Dibromoethane – 1 location
- 1,2-Dichloropropane – 2 locations
- Benzene – 1 location
- cis-1,2-DCE – 2 locations
- Methylene Chloride – 4 locations
- Tetrachloroethene (PCE) – 5 locations
- Trichloroethene (TCE) – 9 locations
- Vinyl Chloride (VC) – 6 locations
- Nitrate – 2 locations

Metals

Based on investigations performed as part of the NES Amendment No. 1, there are no metals that are indicative of potential impacts to groundwater from the Landfill. Of the total metals MCL exceedances, only cadmium in groundwater monitoring well OB11 exceeded the MCL for the field filtered sample (dissolved fraction). Cadmium is a naturally occurring metal with a high affinity for binding with sediment and organic matter, limiting its transport in groundwater. During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), there were no exceedances of chromium reported in the permanent groundwater monitoring wells. Based on the nature of the exceedances, chromium in groundwater is likely a result of suspended sediment and is not indicative of contamination from the Landfill. Continued implementation of refined sampling practices (e.g., field filtration of samples) may be required to define and eliminate total metal exceedances that occur as a result of high turbidity within certain groundwater monitoring wells in future groundwater sampling events.

VOCs

During the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), the reported concentrations of nine (9) VOCs exceeded MCLs. With the exception of 1,2-dibromoethane in groundwater monitoring well OB11A and 1,1-DCE in groundwater monitoring well OB11, MCL exceedances were generally consistent with historical data.

Leachate Indicator Parameters

Nitrate exceeded the MCL (10 mg/L) in groundwater monitoring wells MW-7 (14.9 mg/L) and MW-8 (13.85 mg/L) during the County semi-annual sampling event (April 2011). Nitrate was not detected in groundwater monitoring wells OB11 and OB11A where the greatest number of MCL exceedances were reported. In general, no strong correlations were observed with regard to leachate indicator parameters and reported VOC detections within the groundwater monitoring network associated with the Landfill. This is likely a result of the waste mass age, potential for groundwater mounding, and the Landfill being unlined and not capped (stormwater management practices at the Landfill reduce overall infiltration). As a result, concentrations of leachate indicator parameters are potentially more diluted, resulting in weak to no correlations within the groundwater monitoring network. Similar results were observed for TGWs, where sufficient volume was present to perform analysis on leachate indicator parameters.

9.1.2 Historical Trends and Seasonal Influences

Historical trends and seasonal influences for MCL exceedances were evaluated from April 2001 through April 2011. Seasonal trends indicate that concentrations of parameters with historical MCL exceedances are likely to continue fluctuating in groundwater monitoring wells within the Landfill monitoring network. Not enough data were available to evaluate trends for dissolved cadmium or nitrate. MCL exceedances for 1,1-DCE and 1,2-dibromoethane are not consistent with historical results and therefore, no trends were identified. In addition to seasonal trends, there were several groundwater monitoring wells with increasing trends for cis-1,2-DCE (OB03A, OB03, OB11A and OB11) and methylene chloride (OB11 and OB12). No other increasing or decreasing trends were determined.

9.1.3 Potential Sources of Groundwater Impacts

Potential sources of impacts to groundwater were evaluated and included on-site and off-site sources. On-site sources of potential impacts to groundwater consist of waste, leachate, and landfill gas.

- Waste placed within the Landfill has the potential to include waste from industrial sources and as a result may include chlorinated solvents which are potential impacts to groundwater at the Landfill site.
- Leachate generated through the natural decomposition of waste and exposure of waste to infiltration is a source for potential impacts to groundwater. The Landfill was constructed without a bottom liner and leachate collections system; however, it does have a well vegetated cover system of natural soil and stormwater collection infrastructure to direct uncontaminated stormwater off of the Landfill site.
- Landfill gas is produced by the breakdown of organic matter within the waste mass and can consist of NMOC, which have been identified as potentially impacting groundwater at the Landfill site.

Potential off-site sources of groundwater impacts were also evaluated and include heavy industry and urban environments such as urban roadways, urban residential developments and recreational land use.

- Heavy industry adjacent to the southern Landfill property boundary is a potential source of impacts to groundwater via the infiltration of normal runoff conditions which may include: salt, motor oil and fuels; chemicals used in manufacturing process (bonding agents, surfactants, etc.); metals; and trash.

- Urban environments which have the potential to impact groundwater include urban roadways, urban residential developments and recreational land use. Runoff from roads may include salts, motor oil and fuels, and trash, all of which may be present in surface water which can infiltrate the ground surface and potentially have some impact on groundwater. Likewise, these same potential contaminants may originate from urban residential developments. Other contaminants introduced into the environment stem from residential dumping of household chemicals, as well as the use of pesticides and fertilizers by homeowners or where land use is recreational.

9.2 EXTENT OF POTENTIAL IMPACTS TO GROUNDWATER

Investigations were performed in 2010 to determine the extent of potential impacts to groundwater from the Landfill; these results were included in the NES Report. Based on comments provided by MDE, additional investigations were performed as part of NES Amendment No. 1 to further define the extent of potential impacts to groundwater to the northwest, northeast, southeast and the southwest in the vicinity of the Landfill site.

9.2.1 Groundwater Flow Direction

Similar to the findings of the NES Report, groundwater elevation data collected from the groundwater monitoring wells and stream gauge locations indicated an easterly flow direction across the Landfill, with minor north, northeasterly and southeasterly components. Stream gauge elevations were in agreement with groundwater table elevations from adjacent groundwater monitoring wells, indicating hydraulic connection between groundwater and surface water.

9.2.2 Horizontal Extent of Potential Groundwater Impacts

The extent of potential impacts to groundwater was further defined to the northwest, northeast, southeast and southwest in the vicinity of the Landfill site.

- ***Northwest*** − The extent of potential impacts to groundwater from the Landfill extends slightly into the Derwood Station residential development in the vicinity of groundwater monitoring well MW-9, which is within several hundred feet of the Landfill. Additionally, potential impacts to groundwater exist to the very north of the Landfill site south of Crabbs Branch stream in both permanent and temporary groundwater monitoring wells. There were no MCL exceedances on the north side of Crabbs Branch stream, indicating that the Crabbs Branch stream acts as a hydraulic barrier.

- ***Northeast*** – The extent of potential impacts to groundwater from the Landfill extends slightly into M-NCPPC property in the vicinity of groundwater monitoring wells OB04 and OB04A, which are within a couple hundred feet of the Landfill. There were no other MCL exceedances within the adjacent M-NCPPC property, indicating that with the exception of the area surrounding OB04 and OB04A, the extent of potential impacts to groundwater from the Landfill is limited to the Landfill to the Northeast.
- ***Southeast*** – The extent of potential impacts to groundwater from the Landfill does not extend beyond the current Landfill property boundary to the southeast. All MCL exceedances, with the exception of TCE at MW-4, are present on the north (Landfill side) of Southlawn Branch stream, indicating that the Southlawn Branch stream acts as a hydraulic barrier. The extent of potential impacts to groundwater from the Landfill to the southeast of MW-4 is not bounded by the Southlawn Branch stream; however, the topography of the area indicates that the potential impacts to groundwater are likely localized.
- ***Southwest*** – The extent of potential impacts to groundwater from the Landfill extends beyond the Landfill property boundary into WSSC property in the vicinity of permanent groundwater monitoring well OB12 and temporary groundwater monitoring well TGW-5, located north of Southlawn Branch stream (Landfill side). There were no MCL exceedances on the south side of Southlawn Branch stream in temporary groundwater monitoring wells, indicating that the Crabbs Branch stream acts as a hydraulic barrier.

9.2.3 Vertical Extent of Potential Groundwater Impacts

Based on the NES sampling event (July/August 2010), the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011), MCL exceedances were observed at the greatest frequency in OB11, OB11A, OB03 and MW-13A. However, the vertical extent of MCL exceedances were observed in various groundwater monitoring wells ranging in screen depths from two (2) to one hundred fifty four (154) ft bgs, mostly screened within bedrock.

9.2.4 Site Feature Barriers

Supplemental groundwater elevation, stream elevation, and groundwater analytical data were collected from the stream gauges and temporary groundwater monitoring wells along Crabbs Branch and Southlawn Branch streams. The data demonstrates that the streams are limiting the migration of constituents in shallow groundwater from the Landfill; however, deeper groundwater flow paths may be influenced by the streams, but it is not known to what degree, if any, deeper groundwater is captured by the streams.

9.3 LANDFILL SURFACE HYDROLOGY

NES Amendment No. 1 provides a discussion regarding the site features and topography, stormwater drainage infrastructure, and stormwater diversion that influence surface hydrology at the Landfill, specifically the way in which the Landfill's topography and existing stormwater drainage structures minimize standing water (e.g., ponding) and infiltration into the waste mass.

- The site topography is plateau-like and consists of gentle relief (i.e., slope) along the top of the waste-mass and sharp relief along the Landfill boundary. The elevation along the top of the plateau gently slopes to the south, with localized mounds and depressions throughout. The side slope falls sharply from the top of the waste-mass to elevations ranging from fifty-five (55) to ninety (90) feet (ft) below the plateau. The Landfill surface generally consists of well-vegetated open grassy fields with portions of the site covered by sporadic patches of trees.
- An inventory was performed during 2010 as part of the NES that included existing swales, berms, inlet structures, outlet structures, culverts, detention ponds, and sediment basins. A total of one hundred three (103) stormwater structures were located and assessed in the field. These stormwater and drainage structures aid in minimizing standing water on the Landfill.
- Improvements to the Landfill's cover system and drainage network performed by County DEP in conjunction with its operational Contractors have been actively diverting stormwater off of the Landfill surface from 1984 to present. These improvements have also helped to reduce the potential for stormwater infiltration through the cover system and into the waste mass, thus reducing the potential to generate leachate that would further impact groundwater.

9.4 LANDFILL GAS MANAGEMENT AND GROUNDWATER QUALITY

An evaluation of constituents identified in landfill gas and groundwater was performed using the February 2008 analytical results for landfill gas (Method TO-15 for VOCs) and the analytical results from the County semi-annual sampling event (April 2011). A total of fifteen (15) constituents were identified in landfill gas that had detections in groundwater at the Landfill. Of the identified constituents, seven (7) constituents also exceeded MCLs in groundwater, which included: 1,2-dichloropropane, benzene, cis-1,2-DCE, methylene chloride, PCE, TCE and VC. The results of which indicate a potential relationship may exist between landfill gas and groundwater quality.

Based on the correlation of constituents identified in landfill gas and groundwater, County DEP's active landfill gas management and collection system at the Landfill has been providing benefits to groundwater quality on a full-time continuous basis for approximately twenty-seven (27) years by removing the potential for the fifteen (15) constituents (at the relative concentrations) to condense and enter into the groundwater at and in the vicinity of the Landfill. There is also a similar realized benefit from the gas management and collection system with respect to the decreased potential to emit for green house gases (methane and carbon dioxide) at the Landfill. With respect to the control of constituent concentrations found in landfill gas and associated emissions, the two (2) Landfill Gas Enclosed Ground Flares have a destruction efficiency of approximately 98-99 percent for VOCS and the Landfill Gas-to-Energy Facility has destruction efficiency of 97-99 percent for VOCs.

9.5 HUMAN HEALTH AND ECOLOGICAL RISK EVALUATIONS

Analytical data were reviewed for the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011) and screened in accordance with the screening performed as part of the NES Report. Analytical data from the County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011) were only screened for human health concerns since ecological receptors are not expected to have contact with groundwater. Groundwater analytical results from the groundwater monitoring wells within the Landfill monitoring network identified risk-based COCs with concentrations that are consistent with historical analytical results, including the NES sampling event (July/August 2010).

As noted in the NES Report, vapor intrusion of VOCs into indoor air is the only complete exposure pathway for residents in Derwood Station residential development. The County semi-annual sampling event (April 2011) and the NES Amendment No. 1 sampling event (September 2011) indicated no VOCs as risk-based COCs because the concentrations are less than the level of concern for human health within the Derwood Station residential development. Therefore, there are no human health concerns for resident's exposure to VOCs in groundwater within Derwood Station residential development.

9.6 POTENTIAL IMPACTS TO SURFACE WATER

NES Amendment No. 1 provides a discussion regarding the potential impacts to surface water from the Landfill site and the adjacent land uses of the Landfill. The County has maintained and improved the Landfill's cover system and drainage network since 1984 to actively divert clean stormwater runoff from the Landfill surface. County DEP has also implemented best management practices for post-closure care with the repair of areas experiencing leachate seeps and ponding water at the Landfill. These site management practices and infrastructure improvements have helped to minimize the potential for non-stormwater discharges off of the Landfill site, which has protected the adjacent receiving surface water bodies of Crabbs Branch stream and Southlawn Branch stream.

Similar to groundwater, the potential exists for off-site sources of adjacent land use to impact surface water. The particular land uses that may pose potential impacts to the bordering surface water bodies of the Landfill include: urban roadways, urban residential development, recreational and heavy industry.

Based on the findings provided in the NES Report, the Landfill is not adversely impacting adjacent surface water bodies and no further assessments on potential surface water impacts from or in the vicinity of the Landfill are required at this time.

10. REFERENCES

EA Engineering, Science, and Technology, Inc (EA). 2010a. *Gude Landfill, Waste Delineation Study*. January.

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Appendix A

NES MDE Meeting Minutes

and

Comment/Response Document

NES MDE Meeting Minutes

Comment/Response Document

Appendix B

MW Boring Logs, Development Records, Construction Diagrams and Well Construction Reports

(Included on enclosed CD)

Appendix C

TGW Construction Diagrams

(Included on enclosed CD)

Appendix D

Groundwater Well Purging and Sampling Records

(Included on enclosed CD)

Appendix E

Laboratory Analytical Reports for Groundwater

(Included on enclosed CD)

Appendix F

April and September 2011
Laboratory Analytical Results for Groundwater

Appendix G

Historical Analytical Data Tables

(Included on enclosed CD)

Appendix H

Historical MCL Exceedance Trend Plots

(Included on enclosed CD)